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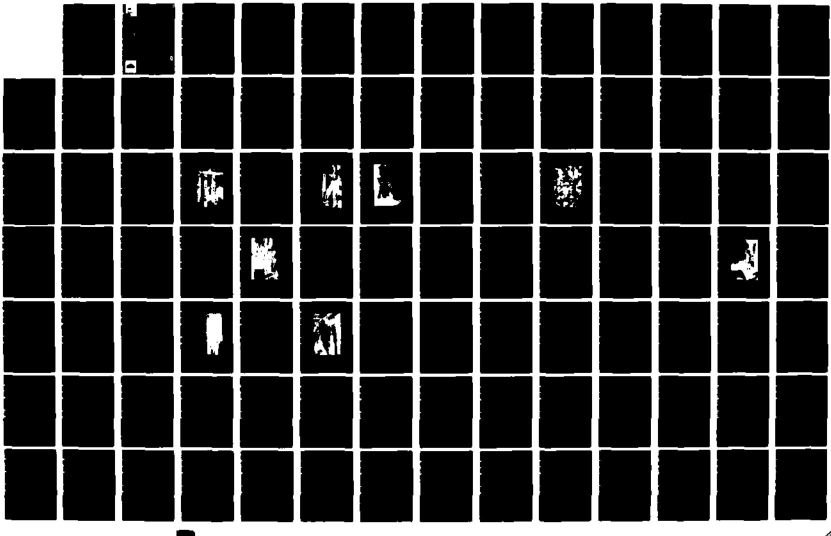


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# A LATERAL-LOAD TEST OF A FULL-SCALE PILE GROUP IN SAND

by


Clark S. Morrison, Lymon C. Reese

Geotechnical Engineering Center
Bureau of Engineering Research
The University of Texas at Austin
Austin, Texas 78712



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Lateral-load tests were performed on a large-scale, well-instrumented group of piles in sand. A similar single pile, also well-instrumented, was tested in the same soil. The group of piles and the single pile were installed in Houston for previous research projects. The native clay soil was removed from the upper portion of the piles and replaced with clean sand. Cyclic lateral loads were applied to the piles, and the response of the instrumentation was recorded.

The results of the load test of the group are compared with the results of current design methods. The methods include DEFPIG, the Focht-Koch method, the single-pile method, and the Bogard-Matlock method. Because none of the methods provided entirely satisfactory results, an analytical procedure is provided which yields good agreement with the results of the load-test.


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## PREFACE

This study was performed by the Geotechnical Engineering Center, Bureau of Engineering Research, The University of Texas at Austin, under contract to the US Army Engineer Waterways Experiment Station (WES), Vicksburg, Mississippi, for the Minerals Management Service, US Department of Interior, the Department of Research, Federal Highway Administration, and the US Army Engineer Division, Lower Mississippi Valley. The study was performed under Contract No. DACW 39-83-C-0061.

This report was prepared by Mr. Clark S. Morrison and Dr. Lymon C. Reese, University of Texas at Austin, and reviewed by Mr. Gerald B. Mitchell, Chief, Engineering Group, Soil Mechanics Division (SMD), Geotechnical Laboratory (GL), WES. General supervision was provided by Mr. Clifford L. McAnear, Chief, SMD, and Dr. William F. Marcuson III, Chief, GL.

COL Dwayne G. Lee is Commander and Director of WES. Dr. Robert W. Whalin is Technical Director.

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# CHAPTER 1

## INTRODUCTION

Closely-spaced groups of piles can be used in a variety of structures to support lateral loads. These structures include lock-and-dam structures, bridge foundations, waterfront structures, and offshore platforms. The use of closely-spaced piles in a group for offshore platforms has increased in recent years as platforms are placed in deeper water and in more severe environments. Under such conditions it is desirable to minimize the number of legs supporting the platform; thus, reducing environmental lateral loads on the structure from waves and currents. The use of groups of piles allows the number of legs to be minimized.

To provide a better understanding of the behavior of closely-spaced piles in a group, load tests were performed on a large-scale, well-instrumented group of piles in sand, and a similar single pile. A 3 x 3 group of piles and a single pile, installed in Houston for previous research projects, were used for the load tests. The native-clay soil was removed from the upper portion of the piles and replaced with clean sand. The piles were instrumented for the measurement of load deflections, slopes at the tops of the piles, and of bending moments at

various depths along the piles. Cyclic, lateral loads were then applied to the piles, and the response of the instrumentation was recorded. The results of the load tests were used to generate load-vs.-deflection curves for the tops of the piles, moment curves as a function of pile length, load-vs.-maximum moment curves, and p-y (soil response) curves for both the group of piles and the single pile.

The results of the load tests were compared with the results of several current design methods. The methods included an elastic method (computer program DEFPIG), the Focht-Koch method, the single-pile method, and the Bogard-Matlock method. Because none of the methods that were studied provided entirely satisfactory results, an analytical procedure is provided which yields good agreement with the results of the load-test.

# CHAPTER 2

## SITE PREPARATION AND SOIL PROPERTIES

### INTRODUCTION

The load tests were performed at a site on the campus of the University of Houston in Houston, Texas. The site was selected because a nine-pile group and several single piles had been installed at the site for a previous research project. The pile group and one single pile were in good condition, and were suitable for use in this project. Using these piles resulted in saving the cost of purchasing and installing piles at a new site. Because the objective of this project was to measure the behavior of a pile group in sand, and the soil at the selected site was an overconsolidated clay, a considerable volume of the native soil was removed and replaced with a suitable sand.

### DESCRIPTION OF SITE

The native surface soils at the test site consist of stiff over-consolidated clays. The surface layer, know locally as Beaumont clay, is a very stiff, highly-plastic clay which was overconsolidated by desiccation. The clay contains numerous fissures and slickensides and has a depth of 24 feet. Below this layer is the Montgomery formation, another desiccated clay with

fewer fissures and some seams of fine, silty sand. The properties of the soil at this site have been documented in detail by Mahar and O'Neill (1983).

A group of nine, 10.75-in.-diameter, steel-pipe piles with a spacing of three diameters and a similar single pile had been installed at the site for previous research projects. These piles were used in this investigation and are described in detail in Chapter 3. A 2-ft-deep pit had been excavated around the piles for a previous research project. All elevations quoted in this report are referenced to the bottom of this shallow pit, not to the original ground surface. A drilled shaft 6 ft in diameter and 36 ft deep had been installed at the site and was used in this project as a reaction for the load test of the pile group. A 48-in. pipe pile had been installed at the site and was used in this project as a reaction for the load test of the single pile. Two 48-in.-diameter casings had been installed at the site and were used as supports for the reference frame. Figure 2.1 shows the site with all relevant structures. Each pile in the group was given a letter label. The pile group and these labels are shown in Fig. 2.2.

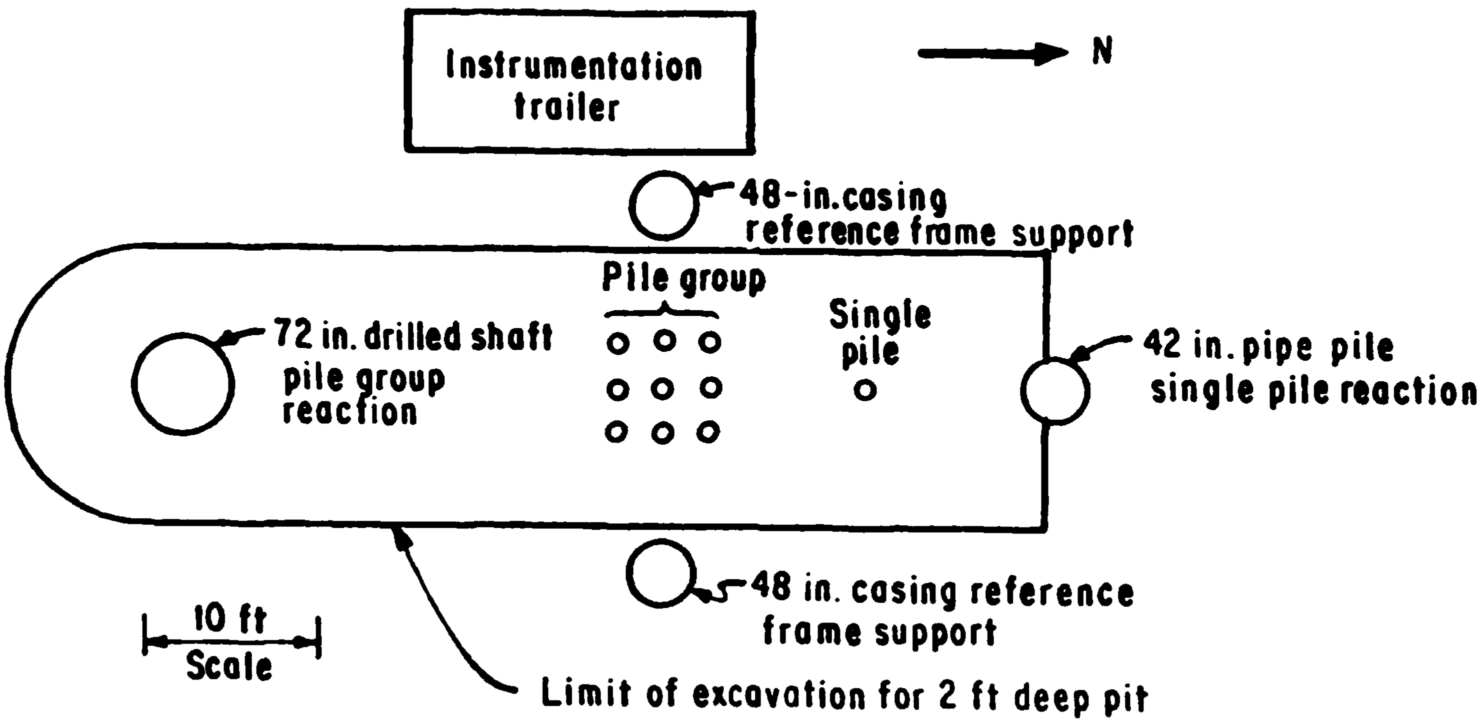



Fig. 2.1. Site plan (after Brown and Reese, 1985).

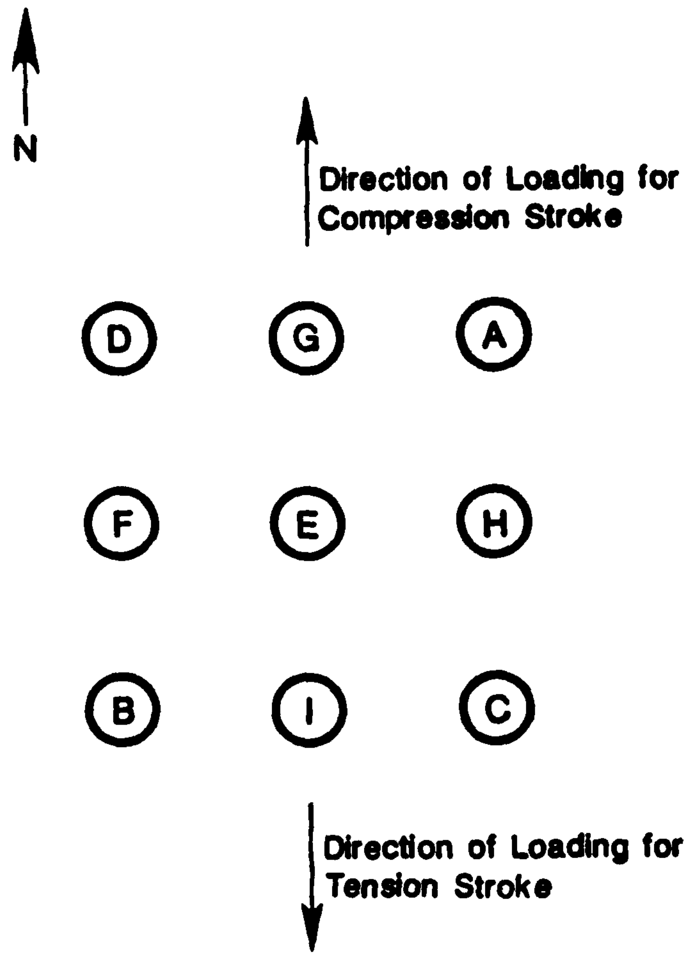



Fig. 2.2. Group pile labels.

## EXCAVATION

In July 1983, the native clay around the pile group and around the single pile was removed to a depth of 9 1/2 feet. Most of the clay was excavated with a backhoe, though some hand excavation was required between the piles of the pile group. The surface of each pile was scraped with a wire brush, and then sprayed clean with water to ensure that no clay remained on any of the piles. A plan view of the excavation is shown in Fig. 2.3. An elevation view is shown in Fig. 2.4. Sketches of PVC pipe are shown in the figures. The function of the pipe will be described later. The dimensions of the excavation were chosen so that the expected surfaces of the soil failure would lie entirely within the mass of sand.

The side slopes of the excavation were left unsupported for one week while the strain gauges were placed on the single pile, and for the two weeks required to place the sand. Early during this three week period, chunks of clay ranging in size from several inches to several feet in diameter would slough off of the side slopes. This was thought to be due to the drying of the fissured clay after being exposed to the air. The sloughing was remedied by covering the side slopes with sheets of clear plastic which retarded or minimized loss of moisture from the clay.

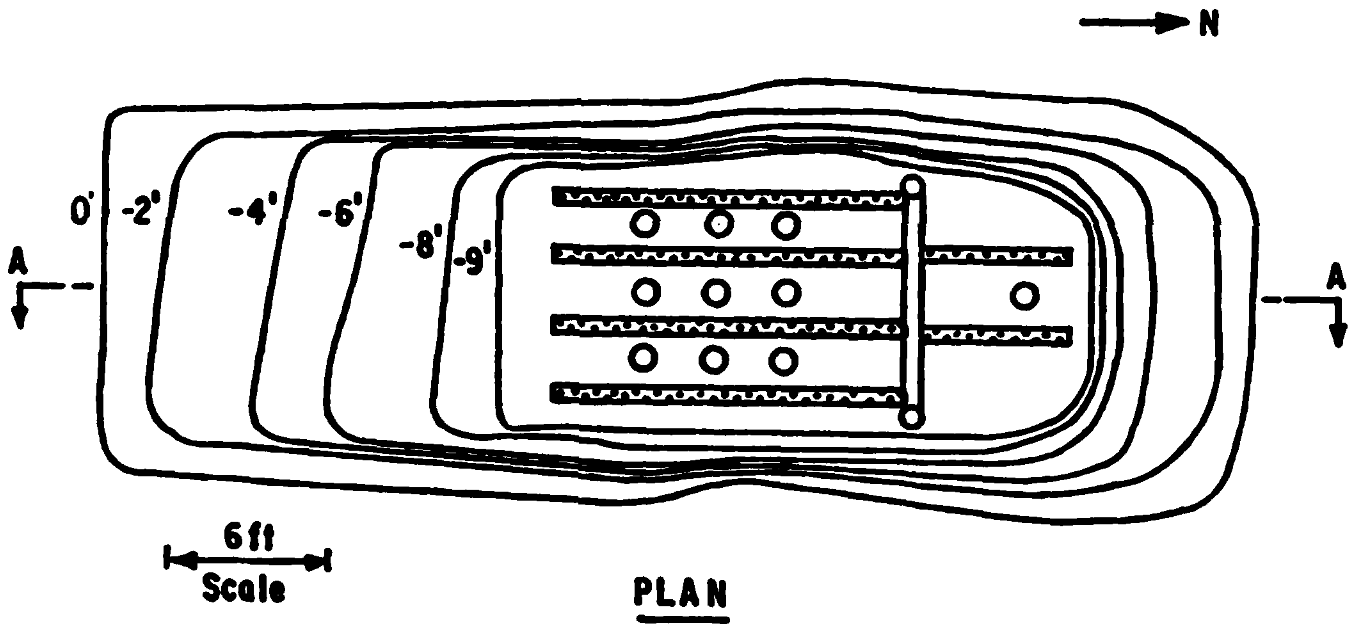



Fig. 2.3. Plan view of excavation and pipe system.

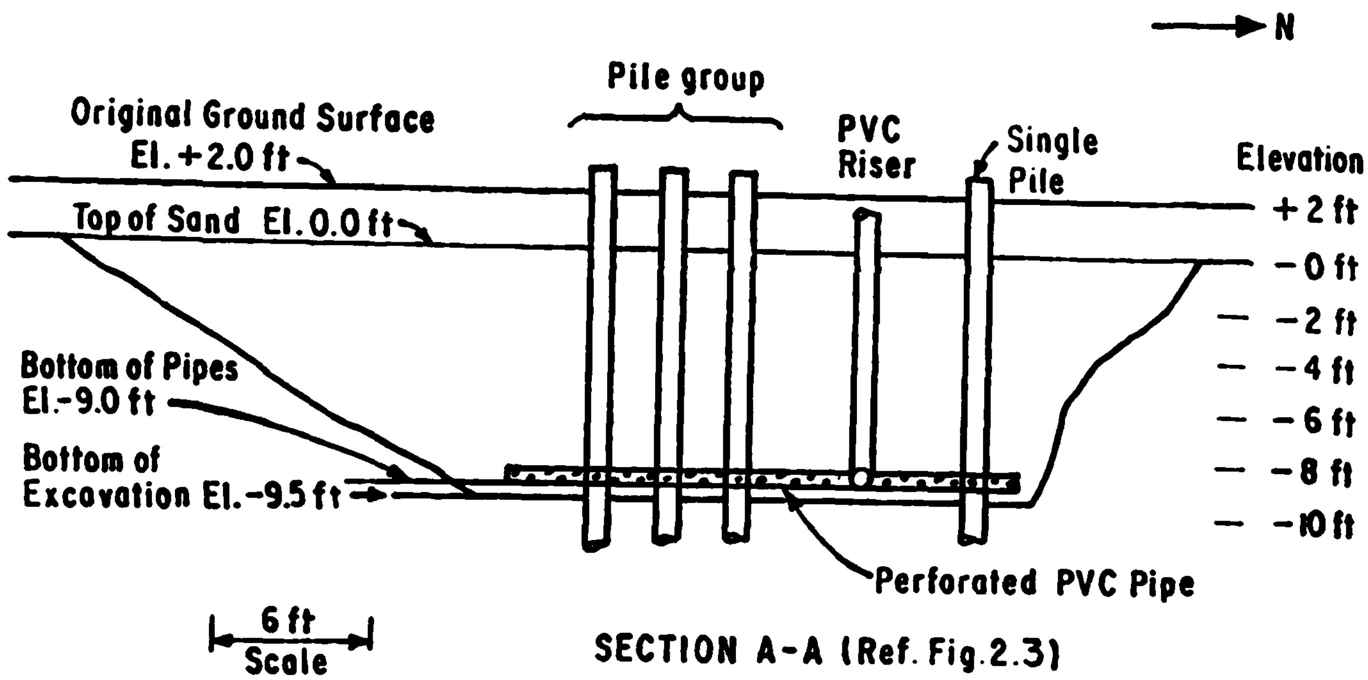



Fig. 2.4. Elevation view of excavation and pipe system.

## PLACEMENT OF SAND

Because it was desired to test the piles while the sand was saturated, and because it is difficult to saturate a soil completely by flooding it from the top, a system of pipes was constructed to introduce water to the bottom of the mass of sand. The system consisted of 4 long and 2 short sections of 4-in., perforated PVC pipe running parallel to the long axis of the excavation into a transverse, horizontal section of 6-in. PVC pipe. Two 6-in. risers led to the surface. This system is shown in Figs. 2.3 and 2.4. The system was useful both for introducing water to the sand, and for pumping water out of the sand.

The sand was compacted in place in 6-in. layers. Sand was dumped into the excavation with a backhoe. The plastic sheets on the side slopes ensured that no clay was mixed with the sand. The sand was then spread with shovels into loose layers 8 in. thick. A small vibratory-plate compactor, a Dyna-pac EY15, was used to compact the sand. The vibratory-plate compactor is shown in Fig. 2.5. Each layer was subjected to three passes of the compactor. The compactor would not fit between the northwest and west-central piles. In this area, and around the sides of all piles, a hand tamper consisting of 12 in. by 12 in. by

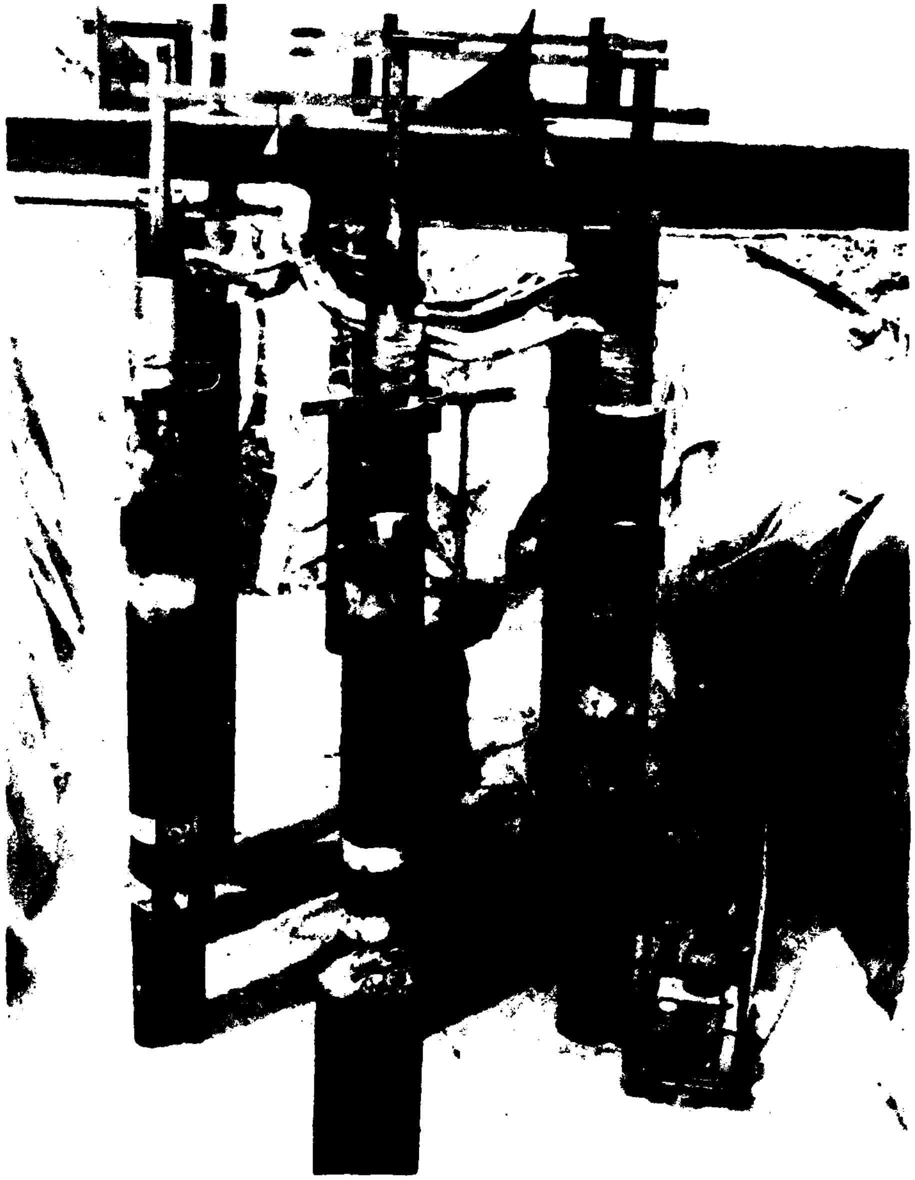


Fig. 2.5. Compaction of sand with vibratory-plate compactor.

1 in. plate, attached to a 3-in. hollow rod, was used to compact the sand. The hand tamper is shown in Fig. 2.6.

The density and moisture content of the sand were measured using a nuclear density gauge. The device used to measure density is shown in Fig. 2.7. Density measurements were taken at nine different elevations. The results of those measurements, dry density and water content, are shown in Table 2.1.

**PROPERTIES OF SAND**

The sand used in this investigation was a uniform, fine-medium sand, Unified Soil Classification SP. Sieve analyses were performed on seven samples of the sand taken at random. The range of the grain-size-distribution curves obtained is shown in Fig. 2.8. The effective grain size, $D_{10}$, ranged from 0.21 mm to 0.24 mm. The coefficient of uniformity, $C_u$, ranged from 1.70 to 1.96. The coefficient of curvature, $C_c$, ranged from 0.88 to 1.32. The angle of internal friction, as measured by direct shear tests, was 38.5 degrees for sand at a dry density of 98.5 pcf. A photomicrograph of the sand used in this experiment is shown in Fig. 2.9.

After the load test described in this report was performed, Ochoa and O'Neill (1986) performed several cone penetration tests in the sand mass. One test, conducted

Fig. 2.6. Compaction of sand with hand tamper.

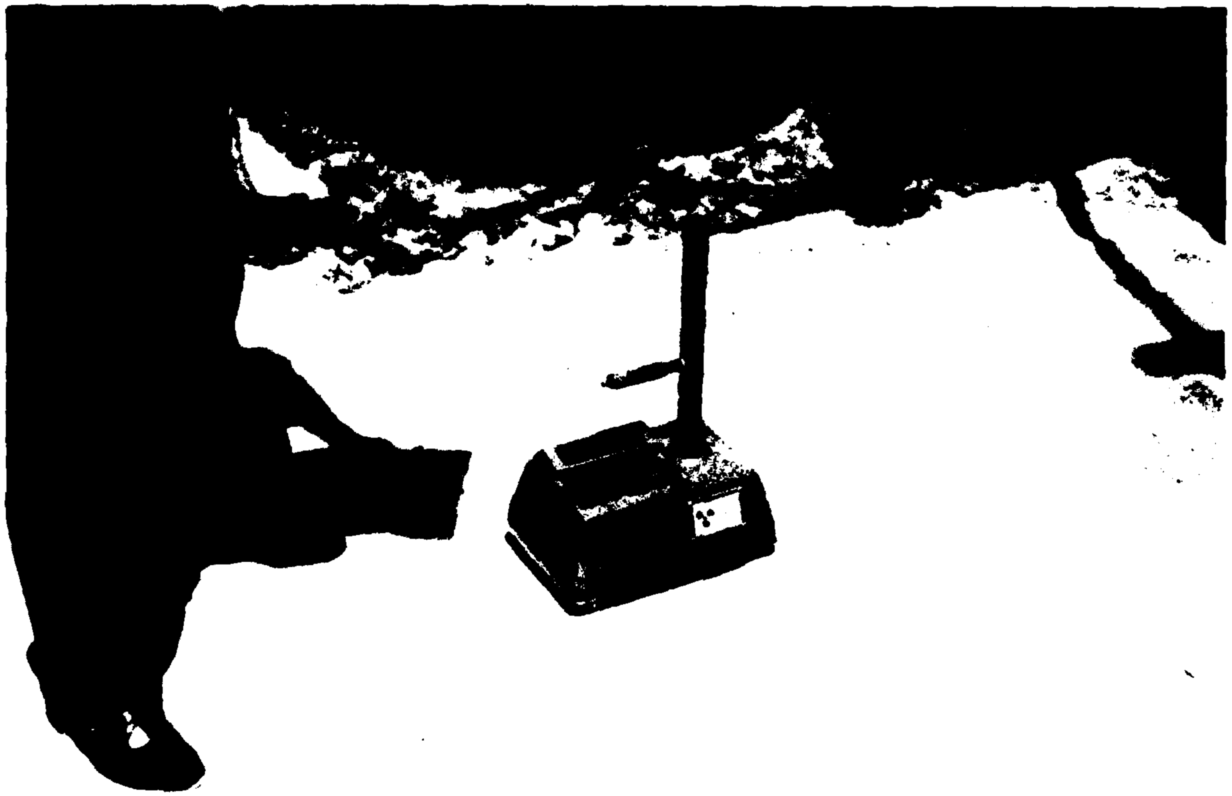


Fig. 2.7. Nuclear density gage.

TABLE 2.1. DENSITY MEASUREMENTS

| Elevation | No. of Measurements | $\gamma_{dry}$, lb/ft$^3$ | | | w, % | | |
|---|---|---|---|---|---|---|---|
| | | avg. | high | low | avg. | high | low |
| -8.0 | 6 | 94.7 | 97.0 | 91.9 | 6.6 | 8.4 | 3.2 |
| -6.0 | 4 | 94.6 | 95.4 | 93.8 | 7.8 | 8.5 | 7.4 |
| -4.5 | 5 | 98.9 | 99.5 | 97.2 | 4.4 | 4.5 | 4.3 |
| -3.5 | 5 | 99.1 | 100.6 | 98.2 | 2.6 | 3.5 | 1.6 |
| -2.5 | 5 | 98.6 | 99.8 | 96.7 | 2.6 | 3.1 | 1.8 |
| -1.5 | 5 | 98.0 | 100.0 | 94.9 | 2.4 | 3.6 | 1.5 |
| -1.0 | 5 | 98.4 | 99.9 | 96.0 | 2.4 | 3.1 | 1.8 |
| -0.5 | 5 | 98.3 | 100.4 | 94.7 | 2.0 | 2.9 | 1.2 |
| -0.0 | 5 | 98.0 | 99.6 | 94.5 | 2.1 | 3.1 | 1.7 |

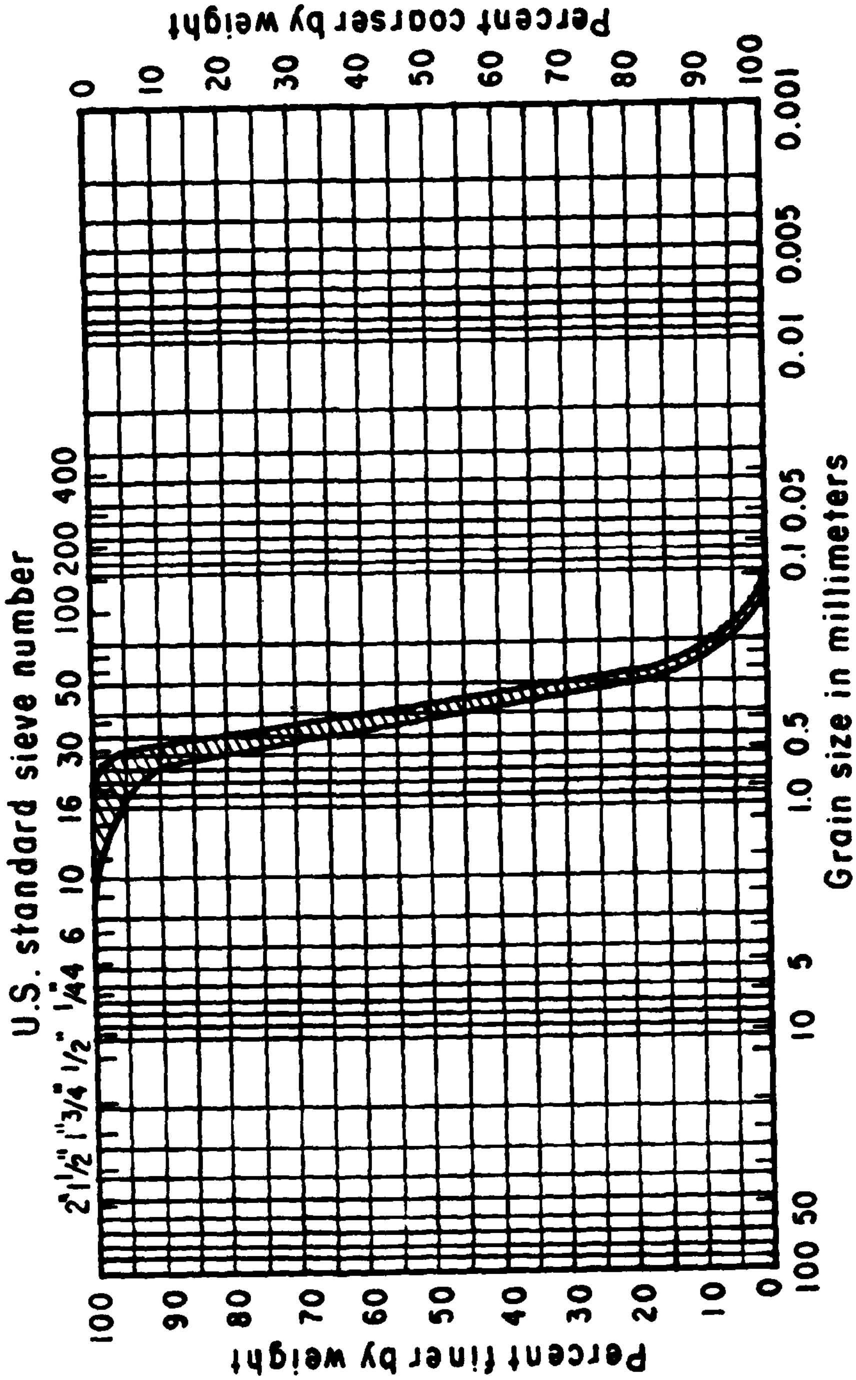



Fig. 2.8. Grain-size distribution of sand.

Fig. 2.9. Photomicrograph of sand (approximate magnification 70 x).

some distance away from the group of piles may represnt initial soil conditions. The results of this test are presented in Fig. 2.10.

**CONCLUDING COMMENT**

A description of the testing site, and the modifications made to the site in preparation for the load tests described in this report were presented in this chapter. It is believed that, as modified, the site provided an economical and experimentally satisfactory opportunity to measure the behavior of a group of piles in sand under lateral load, and to compare the behavior to that of a similarly loaded single pile.

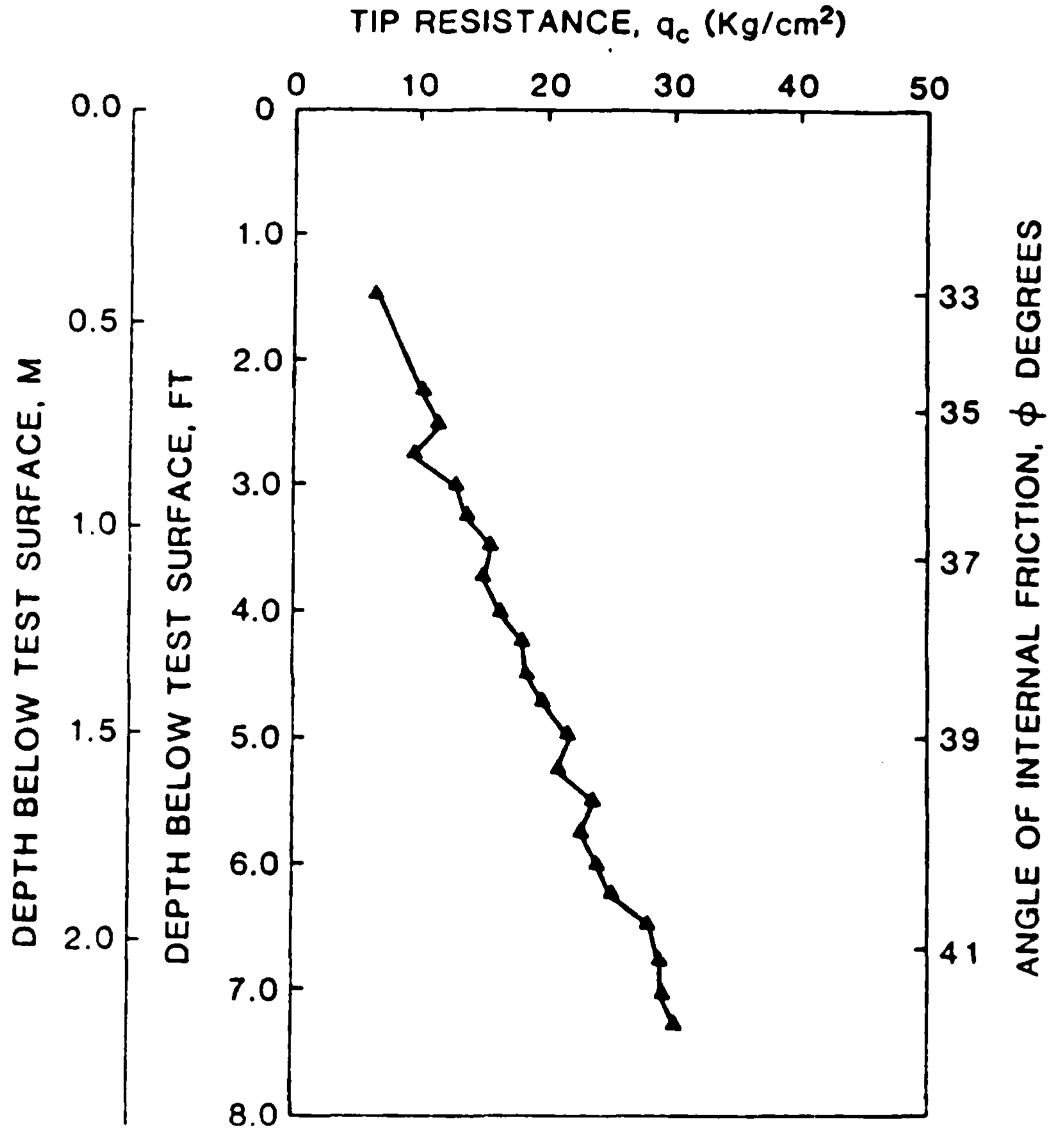



Fig. 2.10. Angle of internal friction vs. depth based on cone penetration test (after Ochoa and O'Neill, 1986).

# CHAPTER 3

# APPARATUS AND INSTRUMENTATION

## INTRODUCTION

The apparatus used for the load test of the pile group was designed and used by Brown and Reese (1985) for testing the pile group in the native clay. Modifications that were made to the loading apparatus before testing and after a failure of the loading system are described in detail in this chapter. The apparatus used in the load test of the single pile, also described in this chapter, was designed to simulate the conditions of the load test of the pile group as closely as economically possible.

## APPARATUS AND INSTRUMENTATION FOR LOAD TEST OF PILE GROUP

### History of Pile Group

As mentioned previously, the pile group tested in this experiment consisted of a 3 by 3 array of steel-pipe piles that were installed in 1979. The outside diameter of the piles was 10.75 in. and the wall thickness was 0.365 inch. The piles were driven closed-ended into the native clay to a depth of 43 feet. A detailed account of the installation of the piles is provided by O'Neill et al (1982a).

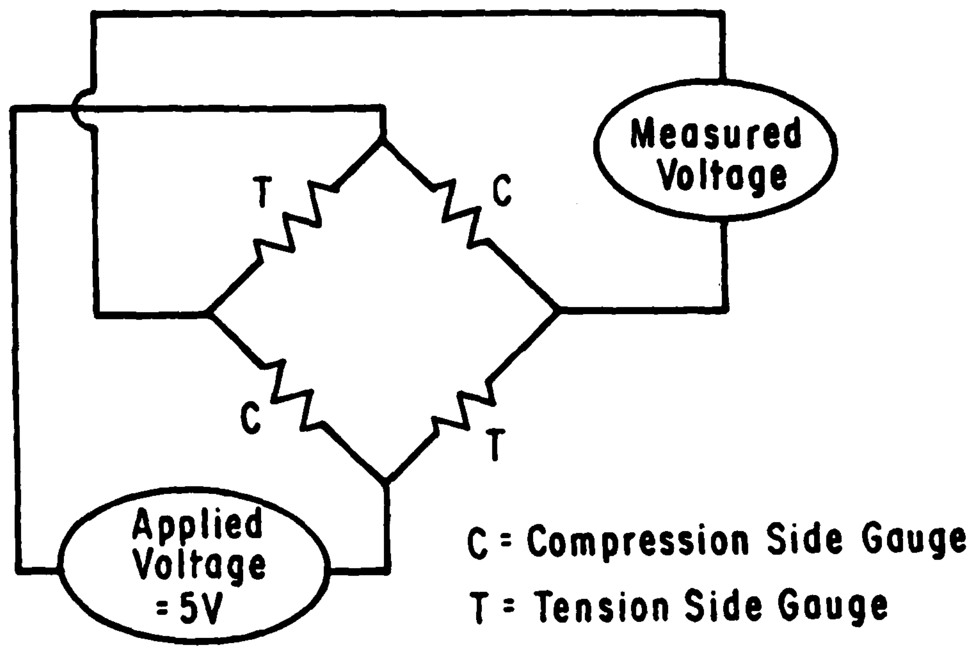
After installation of the piles a concrete cap was cast on the pile group. The group was then loaded axially to failure several times during 1979 and 1980. The axial load tests are described by O'Neill et al (1982b). The dynamic response of the group to a vibrator mounted atop the pile cap was measured between 1980 and 1982.

Starting in the fall of 1983, the pile group was prepared for a lateral-load test. The concrete pile cap was removed. In order to measure bending moment in the piles, a 6 in., schedule 40, steel pipe with strain gauges attached at 11 different elevations was grouted inside each pile in the group. This instrumented insert pipe is described later. After installation of the instrumented pipes, the piles in the group were attached with pin connections to a steel loading frame to which the load was applied. The pile group was then subjected to a deflection-controlled, cyclic, lateral-load test. This load test is described in detail by Brown and Reese (1985). It is believed that none of the piles were stressed above the elastic limit during any of the testing mentioned above.

**Measurement of Bending Moment**

As mentioned previously, an instrumented pipe had been inserted and grouted into each of the piles in

the group for the previous lateral load test. A detailed account of the fabrication and installation of the insert pipes is presented by Brown and Reese (1985). A brief summary is presented here. Strain gauges were placed at 11 elevations, beginning at a depth of 1.0 ft below the surface of the sand, and extending to a depth 13.0 feet. Each gauge-level consisted of two gauges on each side of the pipe. All gauges were placed parallel to the axis of the pipe and were wired in a bridge to cancel axial load and temperature effects. The bridge is shown schematically in Fig. 3.1. Lead wires were attached and the gauges were waterproofed. Spacers were attached to the insert pipe to ensure proper centering in the pile. Care was taken to ensure that the gauges lined up with the direction of loading. Cement grout was pumped down the inside of each insert pipe, and allowed to flow up the annular space between the pile and the insert pipe. Lead wires ran from the piles through PVC pipe into the instrumentation trailer and connected with the data-acquisition system. A schematic drawing of the pile and insert pipe is shown in Fig. 3.2. After the excavation of the clay described in Chapter 2, and before the subsequent placement of the sand, each pile was subjected to a small lateral load that was carefully measured. With the pile acting as a cantilever beam over the depth of




$$\text{Strain} = \frac{4}{\text{Gauge Factor}} \times \frac{\text{Measured Voltage}}{\text{Applied Voltage}}$$

Fig. 3.1. Strain-gage circuit for measurement of bending moment (after Brown and Reese, 1985).

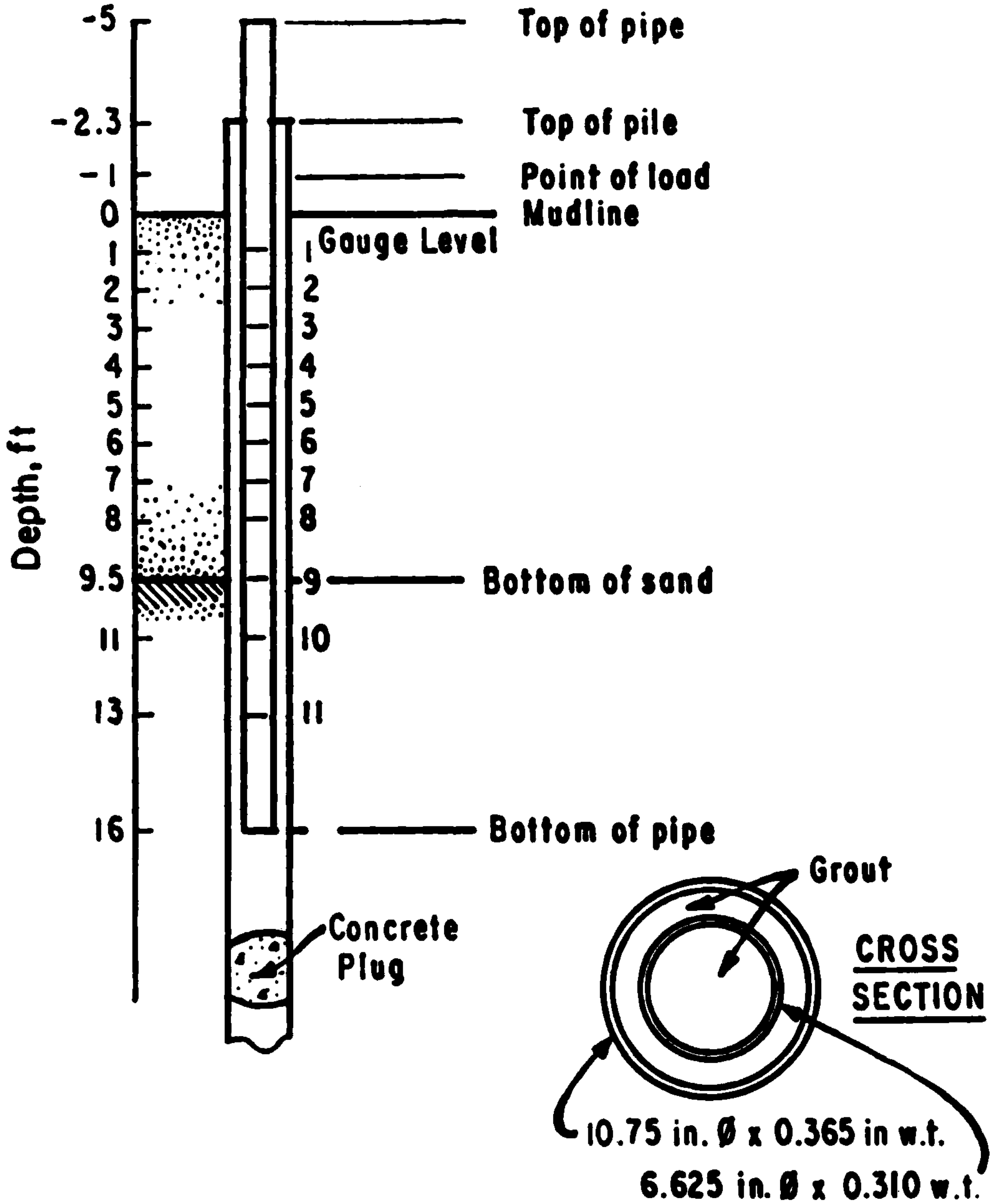



Fig. 3.2. Schematic drawing of a pile in the group and of the instrumentation pipe (after Brown and Reese, 1985).

excavation the strain-gauge bridges could be calibrated against a bending moment of known magnitude.

**Measurement of Deflection and Slope**

Deflections and slopes of each pile in the group were measured using the system developed for the lateral-load test of the pile group in clay. The deflections at two points above the loading point on each pile were measured with 12-in., conductive-plastic, linear potentiometers, which were calibrated prior to the load test. The potentiometers were mounted on a steel reference frame that was supported by two 48-in.-diameter steel casings that extended to a depth of 50 feet. The reference frame is shown in Fig. 3.3.

The distances between the two potentiometers on each pile were measured (ranging from 38.875 in. to 68.125 in.) and recorded. The distances from the loading points up to the bottom potentiometers were also measured and recorded. These measurements allowed calculation of the deflection and slope of each pile at the loading point.

Two additional potentiometers were mounted on the reference frame and attached to the loading frame described in the following section in order to measure the rotation of the frame about a vertical axis.

Fig. 3.3. Photograph of reference frame.

## Loading Apparatus and Measurement of Load

The loading apparatus was designed and fabricated for the lateral-load test of the pile group in the native clay. Each pile was connected to a load cell with a pin. The load cells were in turn rigidly bolted to the loading frame. The load cells were constructed by attaching a full-bridge of T-rosette strain gauges to a 0.125-in.-diameter steel rod. The rod with gauges attached was epoxied into a 0.25-in.-diameter hole that was bored down the centerline of a 1.25-in. diameter rod of cold-rolled steel.

A view of the loading frame is shown in Fig. 3.4. During the load test in clay, problems were encountered with the welds connecting the load-cell-mounting plate to the cross members fabricated of steel channels. In addition, many of the load cells were bent at the end of the load tests in clay.

For economic reasons it was desired to use the loading frame and load cells that were previously used. The bent load cells were carefully straightened with a hydraulic machine and were recalibrated. The connections between the load-cell-mounting plates and the cross members were redesigned using bolts instead of welds. This connection is shown in Fig. 3.5.

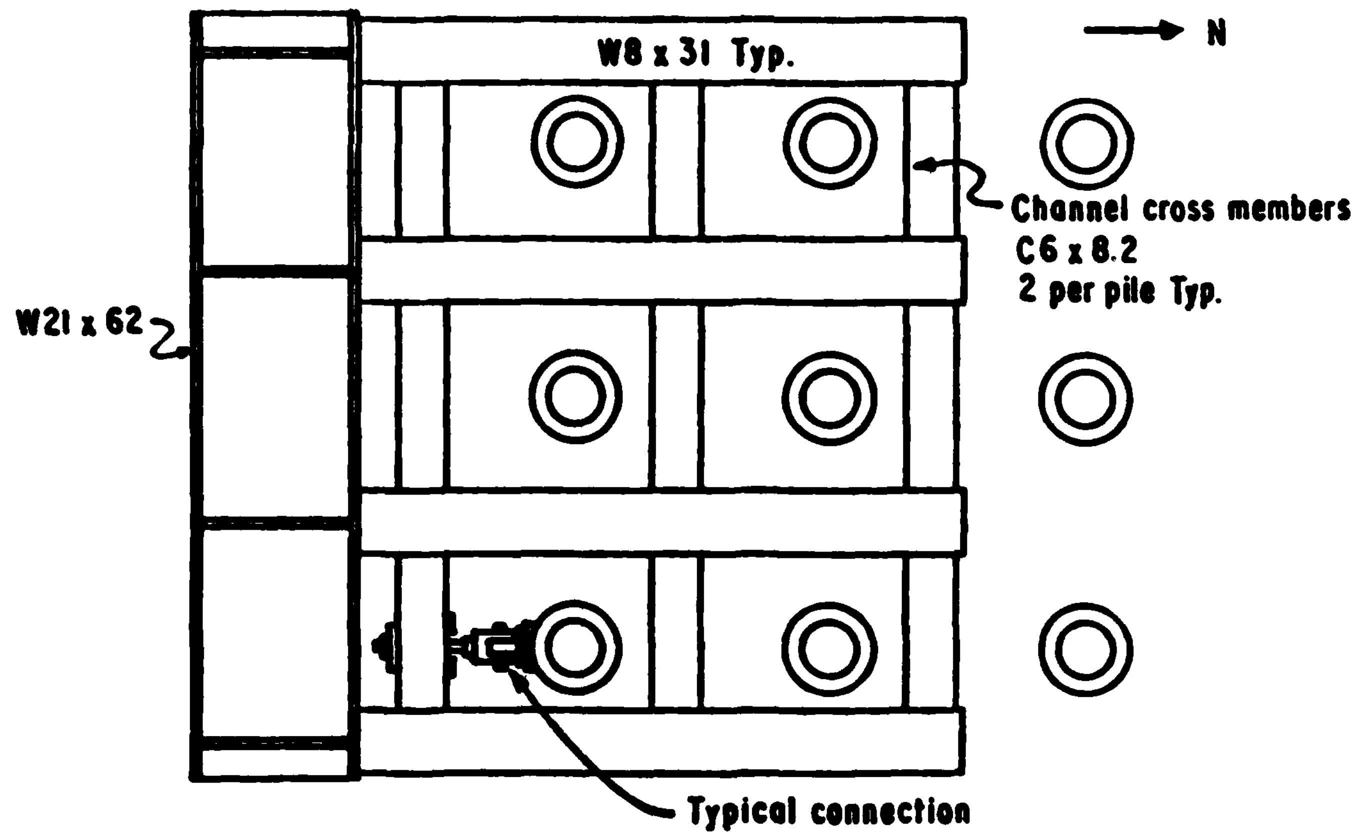



Fig. 3.4. Plan view of loading frame.

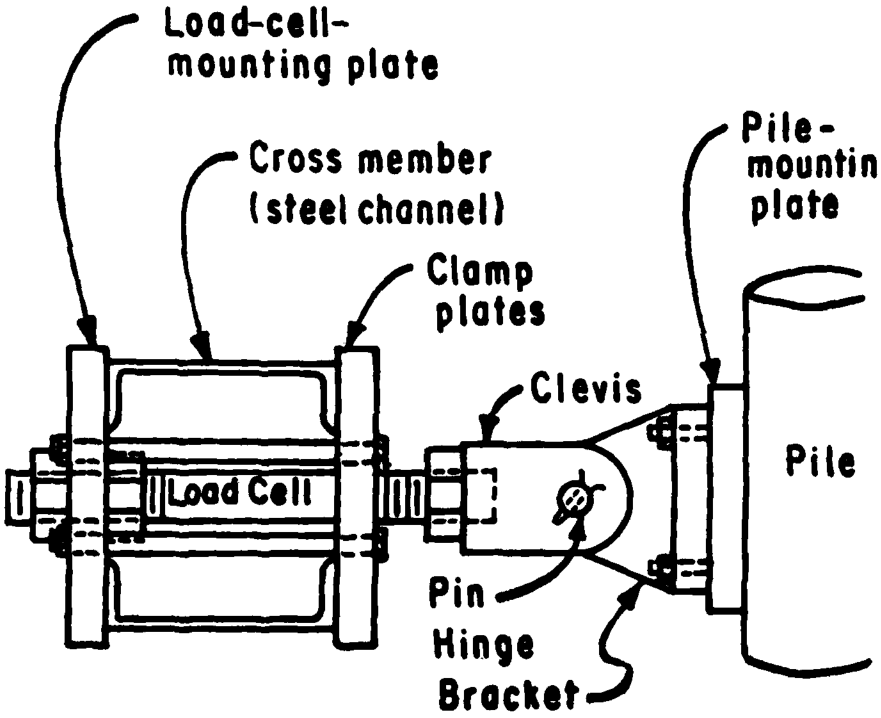



Fig. 3.5. Pile-to-loading-frame connection with 1.25-in.-diameter load cell.

When the load test of the pile group in sand was first attempted, a structural failure occurred in which most of the load cells were bent. This structural failure is described in detail in Chapter 4. New load cells were designed and fabricated. Each of the new load cells consisted of a 2-in.-diameter rod of cold-rolled steel with a full bridge of T-rosette strain gauges attached to the outside surface and waterproofed. One end of the 2-in.-diameter rod was machined to a diameter of 1.25 in. and cut with threads to match those of the clevis for the pin connection to the pile. A new load cell and its connection to the loading frame and the pile are shown in Fig. 3.6. These new load cells survived the further testing with no damage.

A hydraulic-loading system had been designed for the test of the pile group in clay. The system was used unchanged for the load test described in this report. The 6-ft-diameter drilled shaft on the site was used as a reaction. A steel frame, referred to henceforth as the reaction frame, was welded to the casing on the drilled shaft. Load was applied with a 12-in.-diameter-bore, double-acting hydraulic actuator, manufactured by the Miller Fluid Power Corporation. The actuator, with a load cell attached to the ram, was bolted to both the reaction frame and the loading frame. The loading system is shown

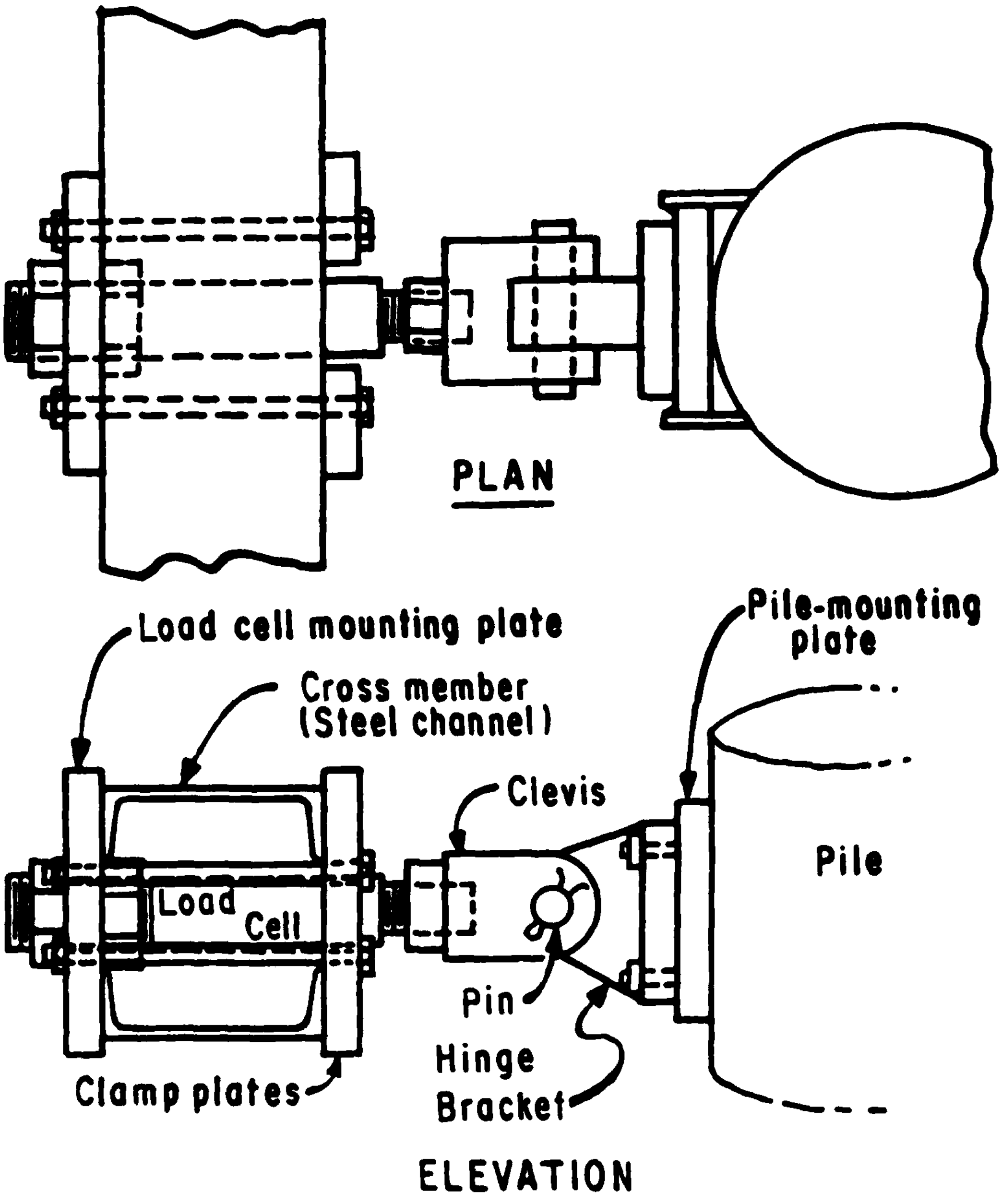



Fig. 3.6. Pile-to-loading-frame connection with 2.0-in.-diameter load cell.

in Fig. 3.7. An MTS model 510.21B hydraulic pump provided fluid pressure to the actuator.

The load-control system was designed for the test of the pile group in clay. The actuator and pump were controlled by an MTS servo valve and a Pegasus Electro Hydraulic Servo Controller. The desired sinusoidal loading pattern was electronically produced with an MTS model 410 Digital Function Generator. A linear potentiometer of the same type used to measure pile deflections provided feedback to the servo controller. The feedback from the potentiometer was monitored with a Dana model 5403 digital voltmeter. The electronic load-control system is shown in Fig. 3.8. For the first attempt, the feedback potentiometer was mounted on the reference frame and attached to the loading frame. After the structural failure, the potentiometer was mounted on the hydraulic actuator and attached to the reaction frame. The reason for this change is discussed in Chapter 4. Limit switches, which would shut off the pump if activated, were mounted on the reference frame on both sides of a vertical extension of the actuator clamp plate. The limit switches were to ensure that no large loads that would damage the piles could be applied accidentally.

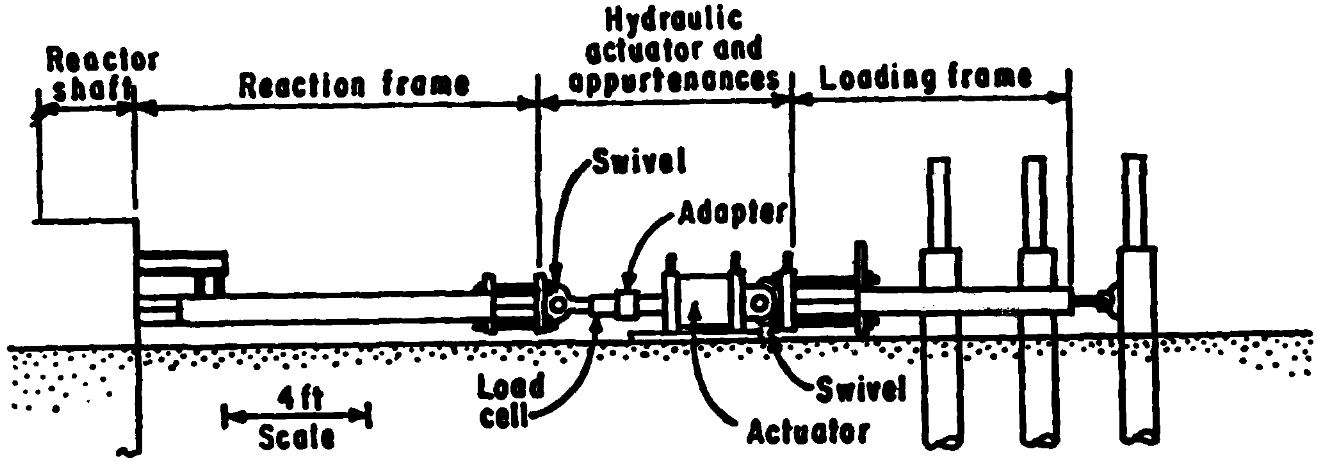



Fig. 3.7. Schematic drawing of the loading system for the pile group.

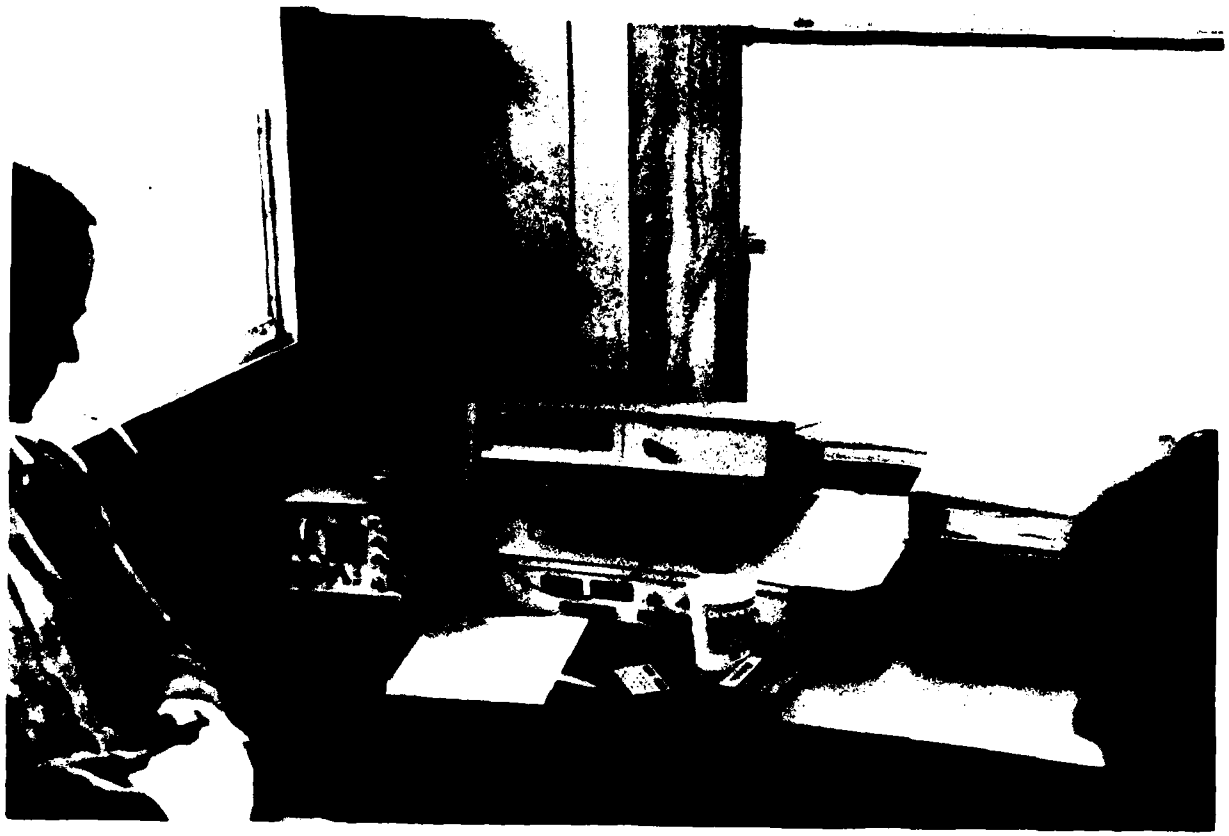


Fig. 3.8. Photograph of electronic load-control system.

### Data-Acquisition System

The data-acquisition system was designed for the lateral-load test of the pile group in clay. The system was used unchanged for the load described in this report. All strain-gauge bridge circuits, linear potentiometers, and load cells were supplied an input potential of about 5 volts with a Hewlett-Packard model 6267B DC power supply. Under the control of a Hewlett-Packard microprocessor, the applied voltage and output voltages from the strain-gauge-bridge circuits, potentiometers and load cells were measured and converted to digital signals by two Hewlett-Packard 3497A Data Acquisition/Control units. The digital signals were then relayed to the microprocessor and stored on a cassette tape. Using the previously measured calibration factors for all the measuring devices and the measured voltages, the microprocessor then calculated bending moments, deflections and slopes, and pile loads. The data were stored on magnetic tape but could be printed on paper tape as the testing proceeded.

## APPARATUS AND INSTRUMENTATION FOR LOAD TEST OF SINGLE PILE

### History of Single Pile

As mentioned previously, the single pile tested in this experiment was installed in 1979. The outside diameter of the steel-pipe pile was 10.75 in. and the wall

thickness was 0.365 inch. Several pressure cells and a 1.5 in. square tube were attached to the inside wall of the pile. The pile was driven closed-ended into the native clay to a depth of 43 feet. A detailed account of the installation of the pile is provided by O'Neill et al (1982).

After installation, the pile was loaded axially several times to failure during 1979 and 1980. The pile was subjected to a load-controlled, lateral-load test in the native clay in the summer of 1984. It is believed that the pile was not stressed above the elastic limit during any of the testing mentioned above.

**Measurement of Bending Moments**

After the excavation described in Chapter 2, the outside of the single pile was exposed to a depth of 9.5 feet. Strain gauges could then be placed on the outside of the pile instead of on an insert pipe. Gauges were placed at 11 elevations, beginning at a depth of 0.0 ft and extending to a depth of 9.0 feet. Each gauge level consisted of 2 gauges on each side of the pipe. All gauges were placed parallel to the axis of the pile and were wired in the same way as was used on the instrumented-insert pipes. Lead wires were attached, and the gauges were water-proofed. The lead wires were tied snugly to the face of the pile to a level above the ground

surface. A drawing of the pile, showing the strain-gauge elevations, is shown in Fig. 3.9. After the gauges were placed, and before the subsequent placement of sand, the pile was subjected to a small lateral load that was carefully measured. With the pile acting like a cantilever beam over the depth of the excavation, the bending moments were known and calibration data could be obtained.

**Measurement of Deflection and Slope**

Deflections and slopes of the pile were measured using a system similar to the one used for the pile group. The potentiometers were mounted on a wooden frame that was supported by two wooden columns driven 2 ft into the ground, 8 ft away (transverse to the direction of loading) from the pile. The reference frame is shown in Fig. 3.10.

The distance between the two potentiometers was 75.6 inches. The bottom potentiometer was 3.0 in. above the loading point. The slope and deflection of the pile at the loading point was calculated in the same way as described for the piles in the pile group.

**Loading Apparatus and Measurement of Load**

One of the original load cells designed and fabricated for the pile group test (1.25 in.-diameter rod with an internal strain-gauge bridge) was used for the single-pile load test. The load cell was connected to the

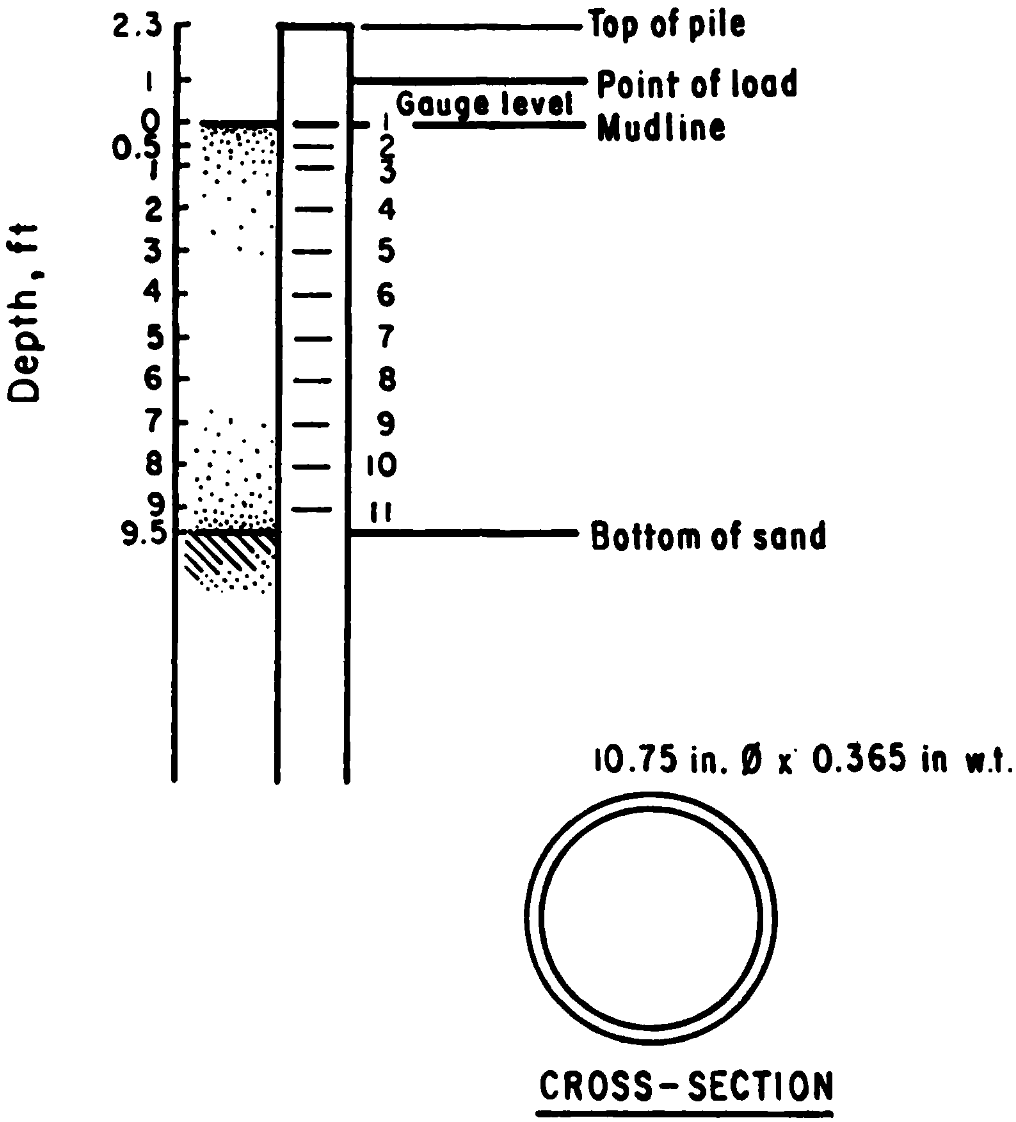



Fig. 3.9. Schematic drawing of single pile.

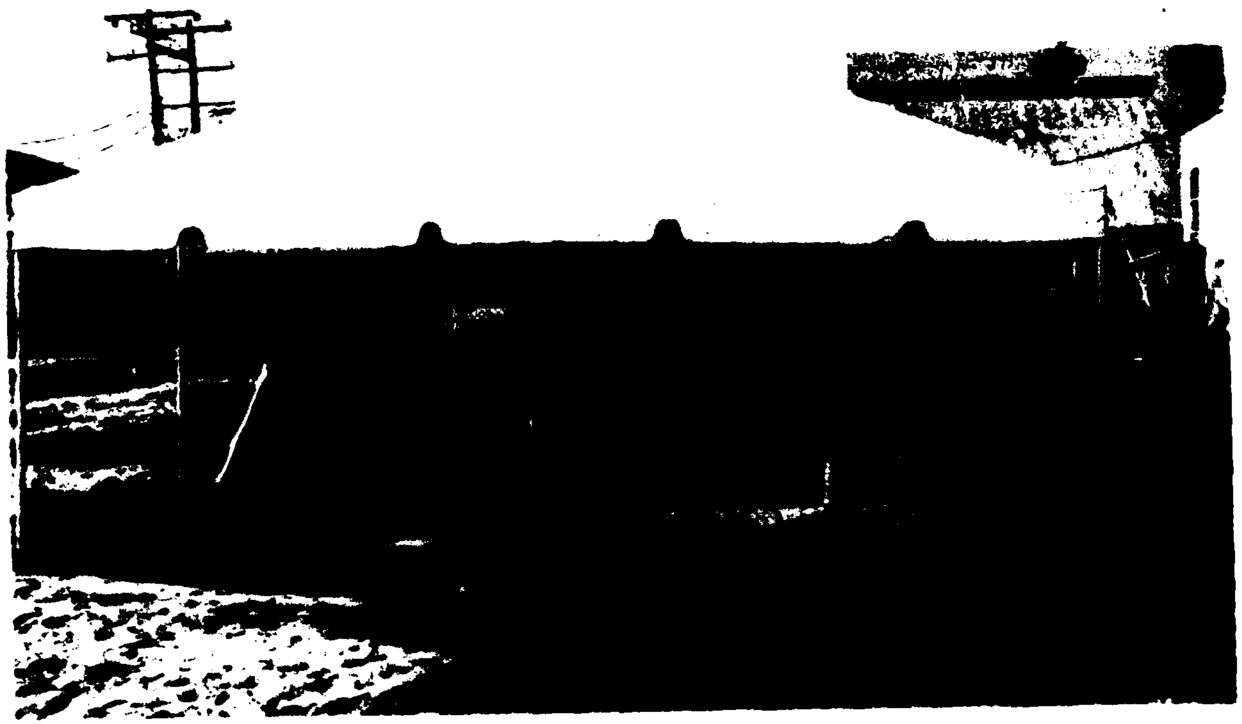


Fig. 3.10. Photograph of reference frame for the single pile.

pile with the same pin-and-clevis apparatus used for the pile group. Instead of mounting into a loading frame, the load cell was connected directly to the ram of a hydraulic actuator with an adapter. The actuator was rigidly bolted to a 1/2 in. plate welded to the end of a W8 x 31 beam which was in turn connected to the 48-in. reaction pile with a single bolt (making a pin connection). The double-acting actuator had a 5-in. diameter bore and was manufactured by the Miller Fluid Power Corporation. The loading apparatus is shown in Fig. 3.11. The actuator was controlled with the same electronic system used in the load test of the pile group.

### Data-Acquisition System

The same electronic system used for data acquisition in the pile group load test was used with the single-pile load test. Because fewer measurements were taken and recorded, however, only one Hewlett-Packard 3497A Data Acquisition/Control unit was required.

## CONCLUDING COMMENT

The apparatus and instrumentation used in the testing of a nine-pile group and a single pile have been described in this chapter. Although a failure occurred during the first loading and some changes were required in the loading system for the pile group, the apparatus

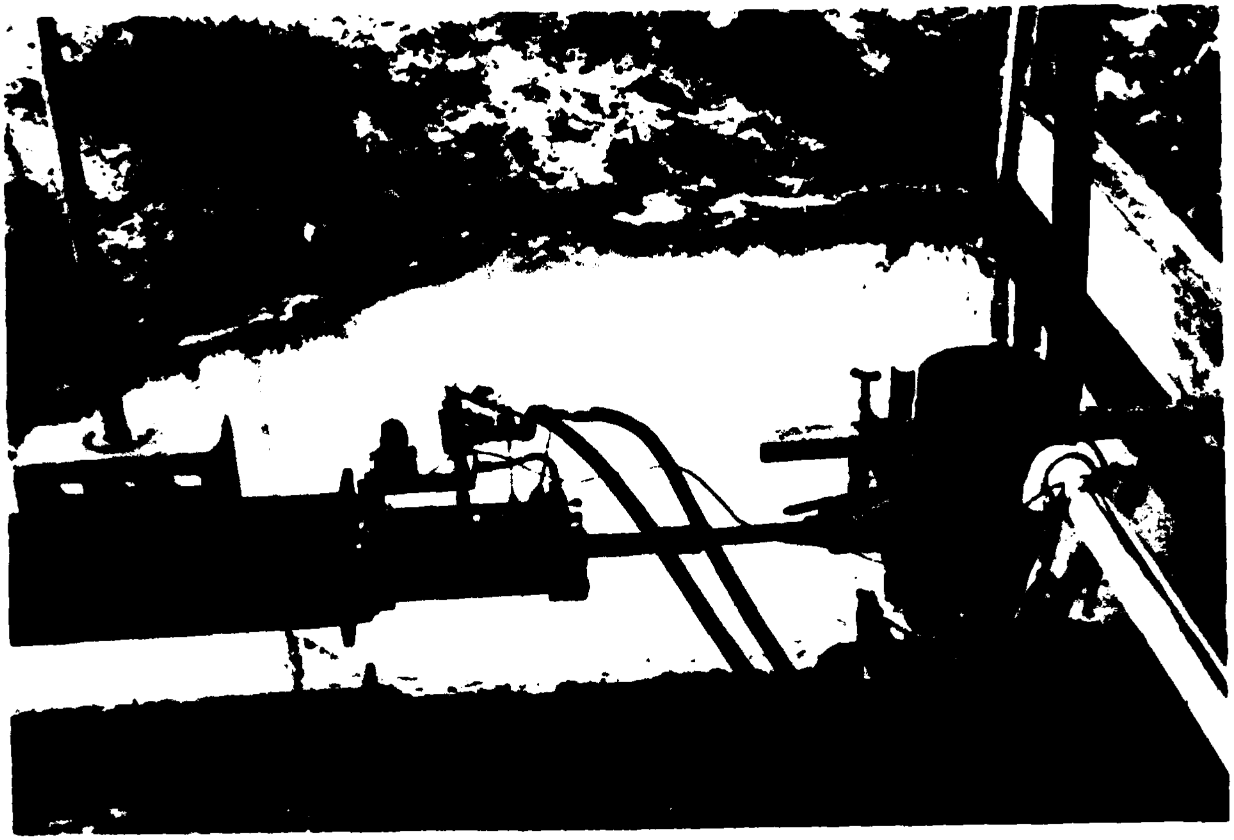


Fig. 3.11. Photograph of loading apparatus for the single pile

eventually allowed the successful completion of a lateral-load test of the single pile and the pile group.

# CHAPTER 4

## TESTING PROCEDURE AND OBSERVATIONS

### INTRODUCTION

Presented in this chapter are the procedures followed for performing both the load tests of the single pile and of the nine-pile group. Events that occurred during the tests and observations made during the tests are also described. A structural failure of the loading system occurred during the test of the nine-pile group. The failure, its cause, and remedial measures that were taken are described in detail in the chapter.

### PROCEDURE FOR DEFLECTION-CONTROLLED TESTING

The following loading procedure was used for both the single-pile load test and the pile-group load test. Two-way cyclic load was applied with the peak deflection being maintained constant in both the forward and backward directions (compression and tension directions) during each loading sequence. For each loading sequence, the deflection was cycled 100 or 200 times. There was some change in the magnitude of the load that was required to achieve the given deflection as cycling continued. Deflection, rather than load, was held constant to reduce the effect of a loading sequence on the behavior of the group during subsequent loading sequences.

For the first loading sequence the deflection was found that corresponded to a load of about 4 kips per pile. Using the manual control on the servo-controller the deflection of the pile or pile group was increased while the load was monitored with a data-acquisition unit. When the desired load was reached the deflection was noted and readings were taken from all instrumentation. The same deflection was then applied in the opposite direction and readings were again taken. The servo-controller then automatically cycled the deflection between the two established maxima. Deflections were held constant while readings were taken at the peaks of cycles 5, 10, 20, 50, 100 and 200. The next loading sequence was for a load of about 8 kips per pile. The same procedure described above was used. The loading was increased in 4-kip increments with deflection being controlled for each loading level. The loading sequences were continued with increasing deflections until it was estimated that the bending stress in the pile (or piles) was the yield stress.

## LOAD TEST OF SINGLE PILE

The load test of the single pile began at 9:15 a.m., October 11, 1984. An initial load of about 4 kips was placed on the pile. A 15 second period was used for the automatic cycling. At about cycle 30 of the first

load, a popping noise was heard just before the peak deflection of the compression stroke. The noise came from inside the pile and is thought to be due to the welded connections of the inclinometer tube to the inside of the wall of the pile. This noise continued intermittently throughout the test. One hundred cycles of the first deflection were applied.

The initial cycle of the second deflection corresponded to a load of about 8 kips. At cycle 180 a small funnel-shaped depression was noticed to have formed around the pile. Two hundred cycles of this deflection were applied.

The initial cycle of the third deflection corresponded to a load of about 12 kips. At cycle 100 it was noticed that the pin connection at the reaction pile was slipping back and forth about 1/16 in. during cycling. Two hundred cycles of this deflection increment were applied.

The initial cycle of the fourth deflection corresponded to a load of about 16 kips. At cycle 50 the funnel-shaped depression had a depth of 7 in. and a radius of 2 feet. Two hundred cycles of this deflection were applied.

The initial cycle of the fifth deflection corresponded to a load of about 20 kips. Two hundred

cycles of this deflection were applied. The shape of the depression in the sand surface at the end of this deflection cycle is shown in Fig. 4.1.

The initial cycle of the sixth deflection corresponded to a load of about 22 kips. Only one cycle was applied. The pile yielded plastically at the sixth gauge level (at a depth of 4 ft).

The initial cycle of the seventh deflection corresponded to a load of about 24 kips. After the first cycle, the HP3497A Data Acquisition/Control unit malfunctioned. A replacement was borrowed from the University of Houston and the test continued after a delay of about 2 hours. One hundred cycles of this deflection were applied.

The eighth deflection corresponded to a load of 26 kips. Only one cycle was applied.

The initial cycle of the ninth deflection corresponded to a load of 28 kips. One hundred cycles of this deflection were applied.

The initial cycle of the tenth deflection corresponded to a load of 32 kips. Ten cycles of this deflection were applied.

The load test concluded at 7:45 p.m. The results of this load test are given in Appendix A.

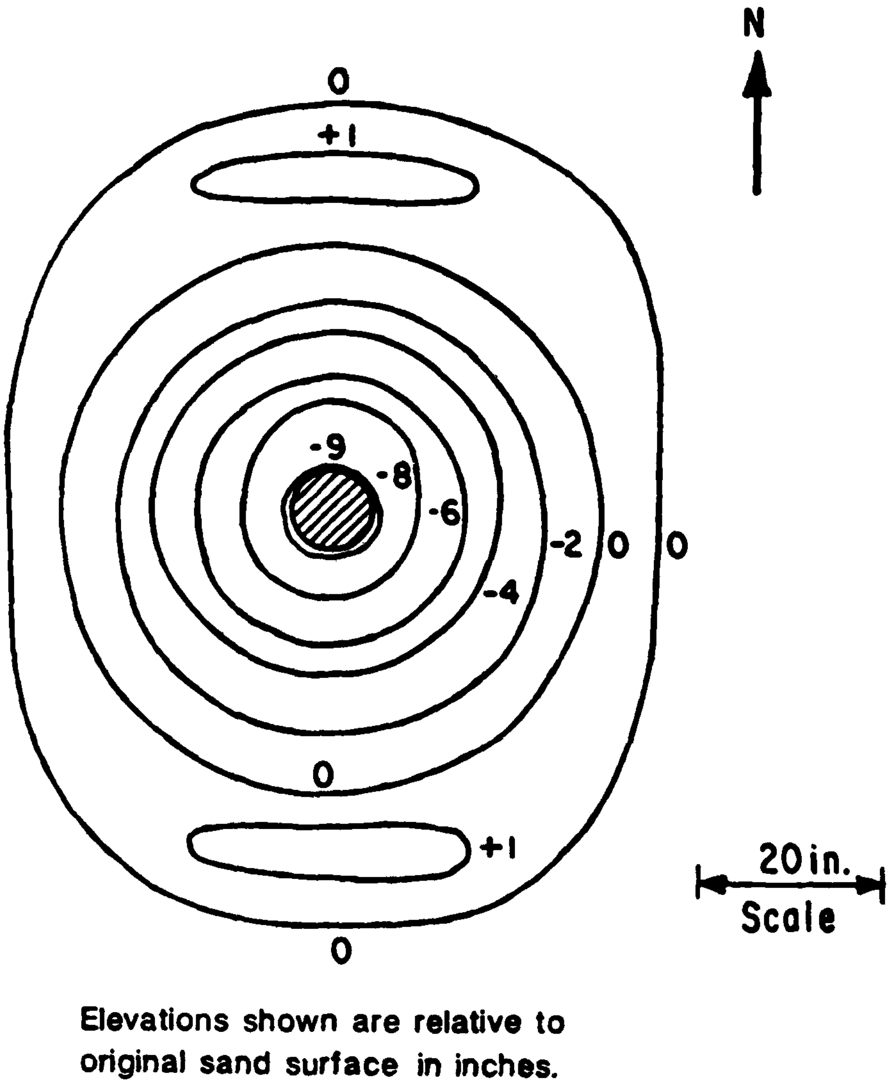



Fig. 4.1. Topography of depression around the single pile.

## LOAD TEST OF PILE GROUP

**Test of October 18, 1984**

The load test of the nine-pile group began at 8:45 a.m., October 18, 1984. An initial deflection corresponding to a load of about 4 kips per pile was imposed on the group. After taking readings, the same deflection was then imposed in the opposite direction. The deflection was then cycled using a 15-second period. At cycle 20 it was noticed that the connections between the two potentiometers measuring the displacement of the loading frame were not functioning properly. The potentiometers were disconnected from the loading frame. One hundred cycles of the first deflection were applied.

Prior to the application of the second load, the disconnected potentiometers were reconnected to the loading frame. The initial cycle of the second deflection corresponded to a load of about 8 kips per pile. The deflection was first applied to the south (frames in tension). Due to an error in operating the servo-controller the deflection applied to the north on the first cycle was too large by a factor of about 2. Because of this error, it was decided to skip the remaining cycles of the second deflection and proceed directly to the third deflection.

The initial cycle of the third deflection corresponded to a load of about 12 kips per pile. The deflection was first applied to the south. The deflection was then applied to the north. Before readings could be taken a structural failure occurred in the loading system. A description and analysis of the failure are presented in the following section. The failure made further testing that day impossible. Testing concluded at 10:30 a.m. The results of this load test are given in Appendix B.

## Failure of the Loading Apparatus

**Description of Failure**. When the failure occurred, both the loading frame and the reaction frame were in compression under a load of about 108 kips. Most of the load cells bent, causing the loading frame to rotate with the north end moving up and the south end moving down. At the same time the north end of the reaction frame moved up. The configurations of the loading system, both before and after the failure, are shown in Fig. 4.2.

**Cause of Failure**. The loading frame was supported entirely by the 9 pins connecting the piles to the load cells. The weight of the loading frame and any misalignment of the hydraulic actuator caused bending moment in the load cells. Under a load of 108 kips (the load applied when failure occurred) the outer fibers of

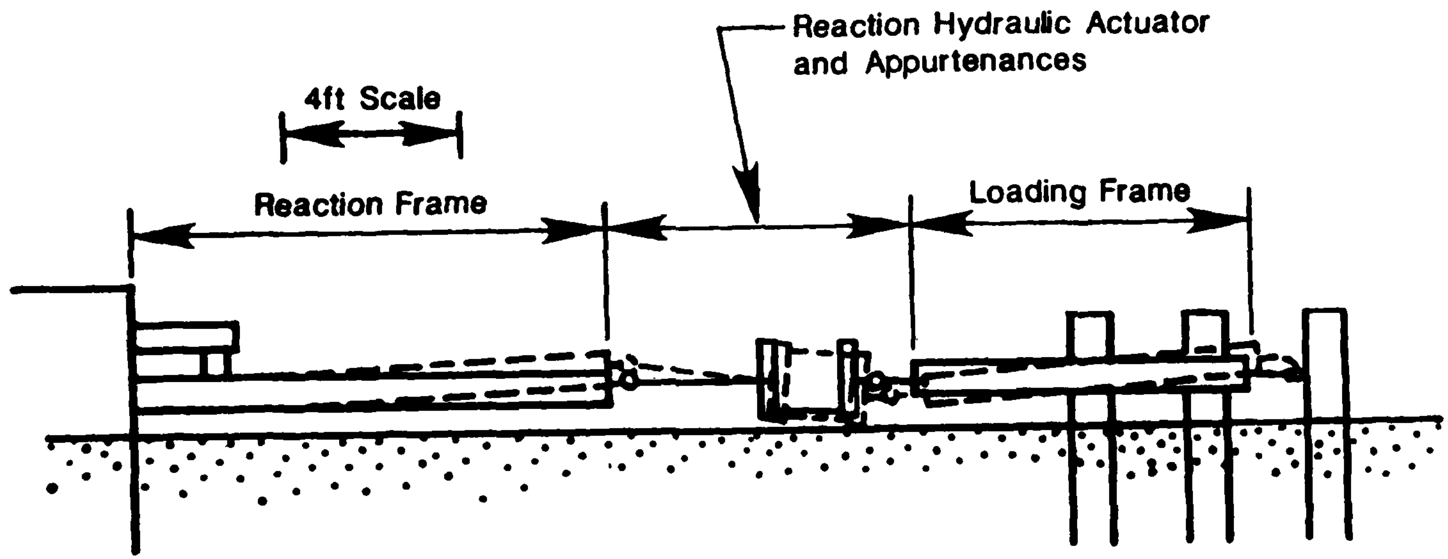



Fig. 4.2. Failure mechanism of loading frame.

the load cells would start to yield if the actuator was installed more than 0.4 in. off-center vertically or if the actuator was installed at an angle greater than 0.25°. It is believed that the actuator was installed at too great an angle, causing the load cells to yield and the loading frame to rotate. The rotation of the loading frame increased the angle of the actuator, causing further bending of the load cells and buckling of the reaction frame. The failure process was stopped by pushing the emergency shut-off button on the servo-controller.

The failure mechanism should have been stopped quickly, after it started, by the servo-controller and by the limit switches. This was prevented by the placement of the potentiometer providing feedback to the servo-controller and the placement of the limit switches. The position of the loading frame both before and after failure, and the positions of the feedback potentiometer and limit switches are shown in Fig. 4.3. The feedback potentiometer was mounted on the reference frame about 18 in. above the loading frame, and was connected to a 2-ft length of angle welded to the loading frame. The limit switches were mounted on the reference frame and positioned on both sides of a vertical extension of the actuator-clamp plate. When the failure occurred, the loading frame was moving to the north and rotating at the

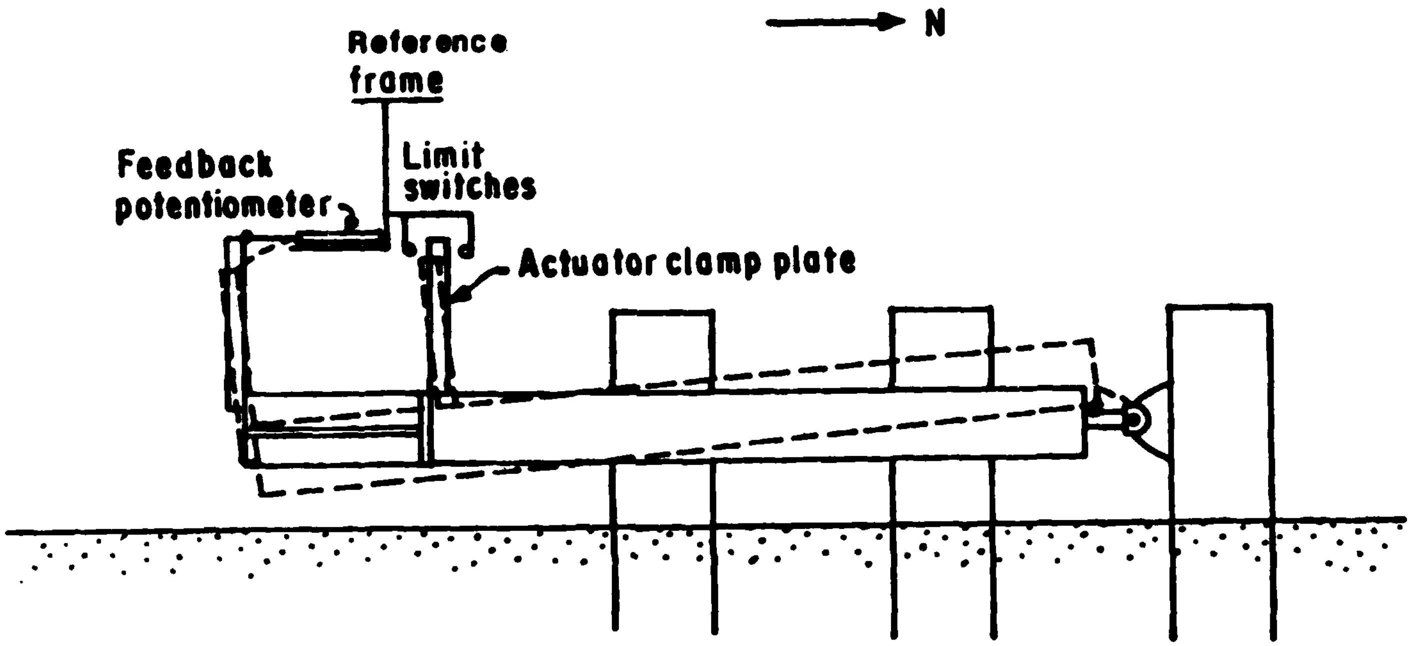



Fig. 4.3. Position of load-control devices.

same time. The rotation caused the point of attachment to the feedback potentiometer to move south. As a result, the servo-controller continued to provide pressure to the actuator after the desired displacement had been reached. The rotation of the loading frame also caused the extension of the actuator-clamp plate to move out from between the limit switches without tripping either one. The automatic shut-off system was thus neutralized, and the loading continued until the hydraulic pump was manually turned off.

**Repair and Modification of the Loading System**. Constraints on time and funding prevented a complete redesign of the loading apparatus. Instead, the portions that suffered damage were repaired or replaced. The reaction frame was bent back into its original position with hydraulic jacks. A horizontal beam, supported by two steel H-piles, was erected over the north end of the reaction frame. Struts were placed between the beam and reaction frame to ensure that no vertical movement of the frame could take place. The sections of the reaction frame that had yielded were reinforced with steel plate. New load cells with a larger cross section, were fabricated and installed in the loading frame. The new load cells were described in Chapter 3. The new load cells would start to yield at a load of 180 kips if the

actuator was installed more than 2.1 in. off center or at an angle of more than 1.0°.

To ensure proper control of the loading apparatus, the feedback potentiometer was moved from its original position. The potentiometer was mounted on the actuator casing and attached to the adapter mounted on the ram of the actuator. As a result, any change in the deflection of the reaction shaft after the initial application of each deflection would result in a change in the deflection of the pile group. This effect was thought to be small, and was considered a reasonable trade-off for preventing another structural failure. The location of the limit switches was not changed. It was believed that the measures that were taken were adequate to prevent another failure.

**Test of December 13, 1984**

The second attempt to load the nine-pile group began at 10:15 a.m., December 13, 1984. An initial deflection corresponding to a load of about 4 kips per pile was imposed on the group towards the north. After taking readings, the same deflection was imposed on the group towards the south. The deflection was then cycled using a 20-second period. Due to an error in operating the servo-controller, for cycles 2 through 4 the deflection was applied in only one direction, towards the

north. One hundred cycles of this deflection were applied.

The initial application of the second deflection corresponded to a load of about 8 kips per pile. After cycle 10, the position of the actuator on the loading frame was adjusted because the west side of the loading frame was deflecting more than the east side. One hundred cycles of this deflection were applied.

The initial application of the third deflection corresponded to a load of about 12 kips per pile. Two hundred cycles of this deflection were applied.

The initial application of the fourth deflection corresponded to a load of 16 kips per pile. At cycle 17 vertical movement of the loading frame was noticed. Cycling was stopped, and the position of the actuator was adjusted. No further vertical movement was noticed. Two hundred cycles of this deflection were applied.

The initial application of the fifth deflection corresponded to a load of about 20 kips per pile. During cycling of this deflection the water level in the risers of the saturation system would change elevation by about 0.9 inch. At all times the level of the water in the riser was 1 to 2 in. above the level of the water ponded on the sand. At cycle 168 the potentiometer providing feedback to the servo-controller broke. It was replaced

with top potentiometer from pile H. Two hundred cycles of this deflection were applied.

The test concluded at 9:30 p.m. The results of this test are given in Appendix C.

**CONCLUDING COMMENT**

The procedures followed for performing both the single-pile and pile-group load tests have been presented in this chapter. A description of the failure of the loading system that occurred during the pile group test was also included. The procedures that were followed allowed the collection of a large amount of data that is given in Appendices A, B, and C and summarized in the following chapter.

# CHAPTER 5

# SUMMARY OF TEST RESULTS

## INTRODUCTION

A large amount of data was collected during the load tests of the single pile and the group of piles. These data are tabulated in Appendices A, B, and C. A summary of the test results is presented in this chapter. This summary includes presentations of dependency of pile-head load on cycling, load vs. deflection curves, pile moment curves, load vs. maximum moment curves, and soil-response curves for both the single pile and the group of piles.

## RESULTS OF LOAD TEST OF SINGLE PILE

### Dependency of Pile-Head Load on Cycling

As mentioned previously, a number of cycles of each deflection was applied to the single pile. Each cycle consisted of applying the deflection first to the south (referred to here as the compression stroke since the loading apparatus was in compression) and then applying the same deflection to the north (referred to here as the tension stroke). The measured pile-head loads and corresponding load-point deflections for the compression strokes are shown in Fig. 5.1. Those for the

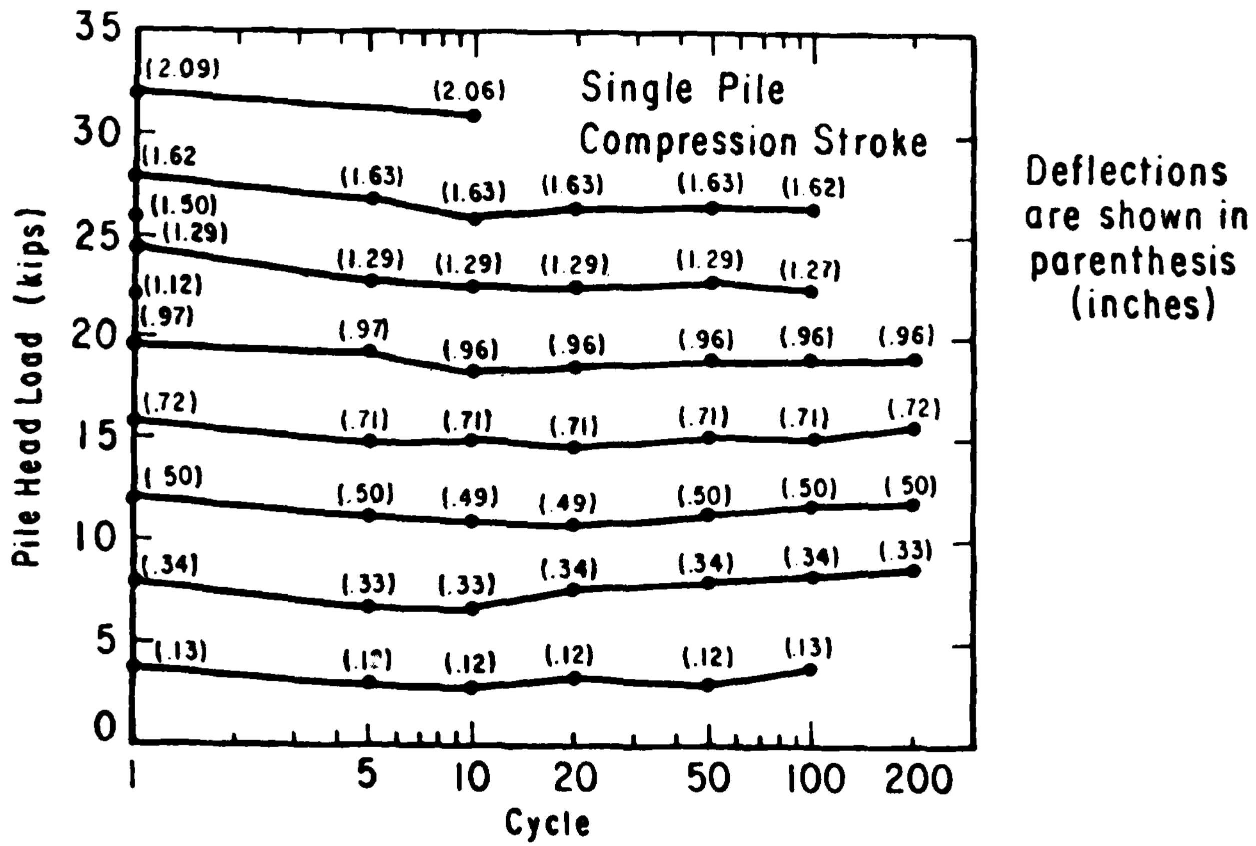



Fig. 5.1. Loads and deflections applied on compression stroke of cycle, single-pile test.

tension stroke are shown in Fig. 5.2. As can be seen from these figures, deflections were maintained constant to within 0.02 inch. For a given deflection, the pile-head load only changed slightly as additional deflection cycles were applied. In most cases the pile-head load decreased slightly up to cycle 10 and then increased slightly up to the last cycle. The load measured on the tension stroke was always less than that applied on the compression stroke.

**Load versus Deflection**

The variation of pile-head load with deflection for cycle 1 of each deflection is shown in Fig. 5.3. A similar relationship for cycle 100 is shown in Fig. 5.4. The load-deflection curve for cycle 100 shows a slightly "softer" behavior than the load-deflection curve for cycle 1. "Softer" indicates more deflection for a load of the same magnitude.

**Moment Curves**

Measured moment curves for cycle 1 and cycle 100 deflections 1, 3, and 5 are shown in Figs. 5.5, 5.6, and 5.7. The moments are normalized by dividing by the pile-head load in order to compare curves for different loads. For the first load the maximum normalized moment is slightly smaller for cycle 100 than for cycle 1. This implies that cycling at small deflections caused the sand

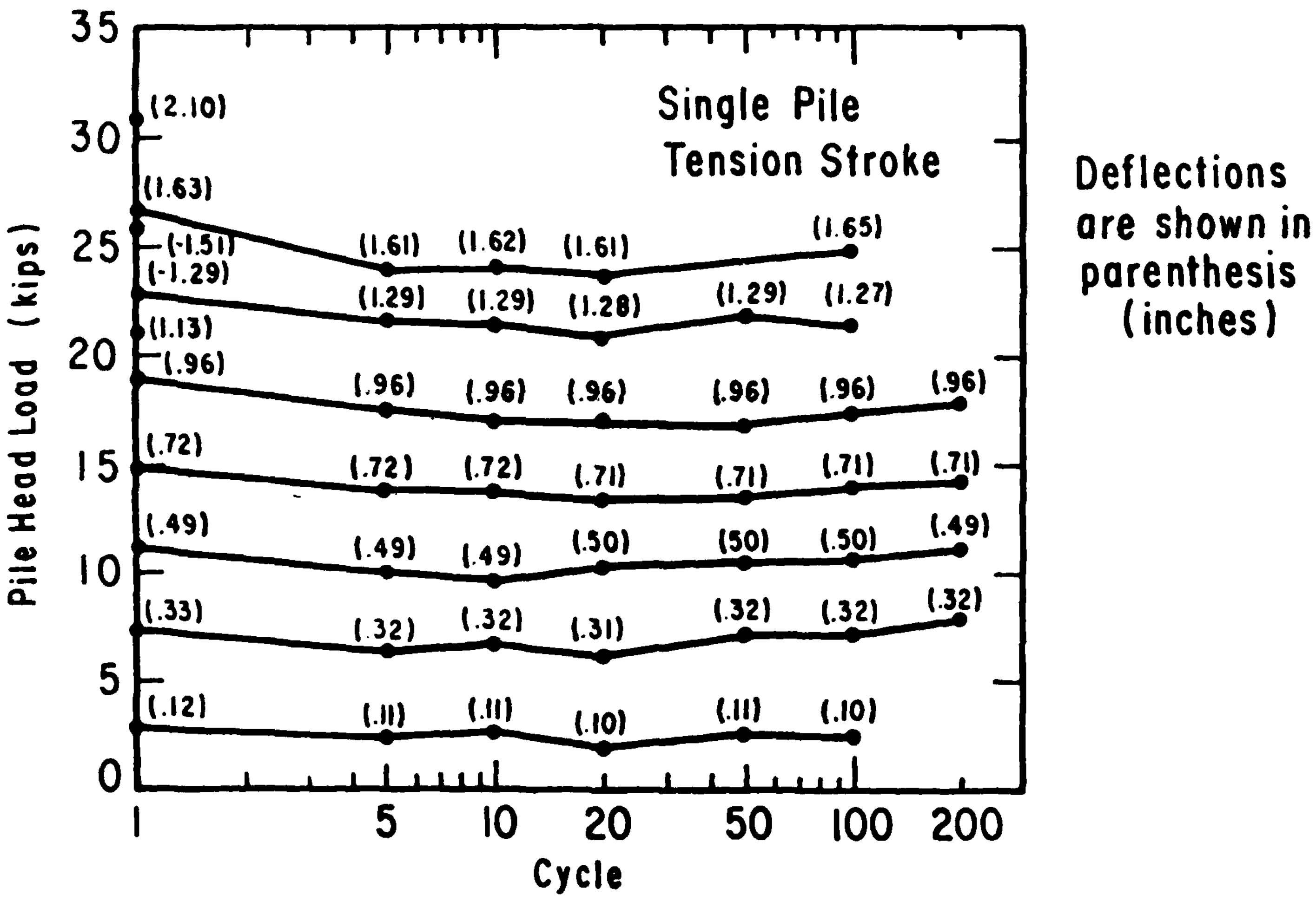



Fig. 5.2. Loads and deflections applied on tension stroke of cycle, single-pile test.

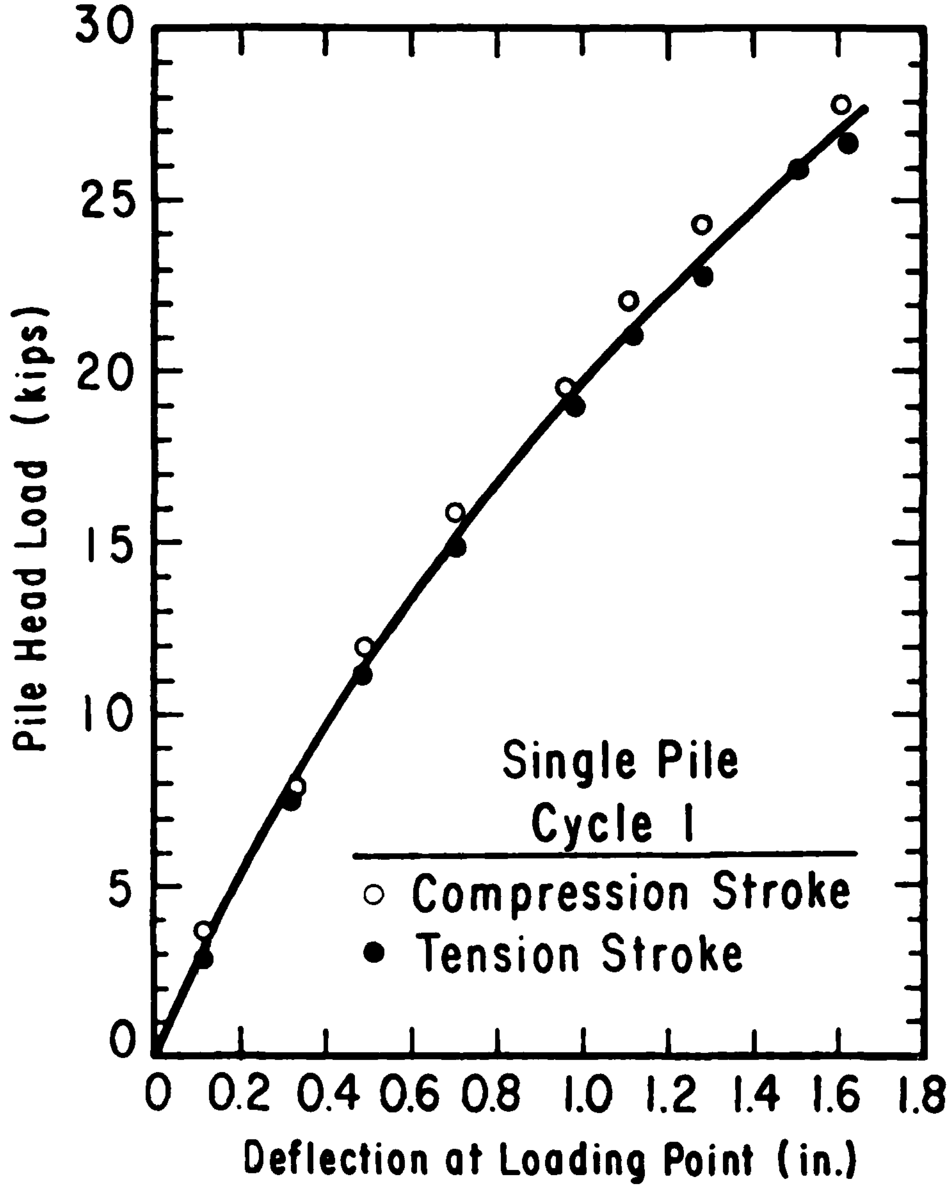



Fig. 5.3. Load-deflection curve for single pile for cycle 1.

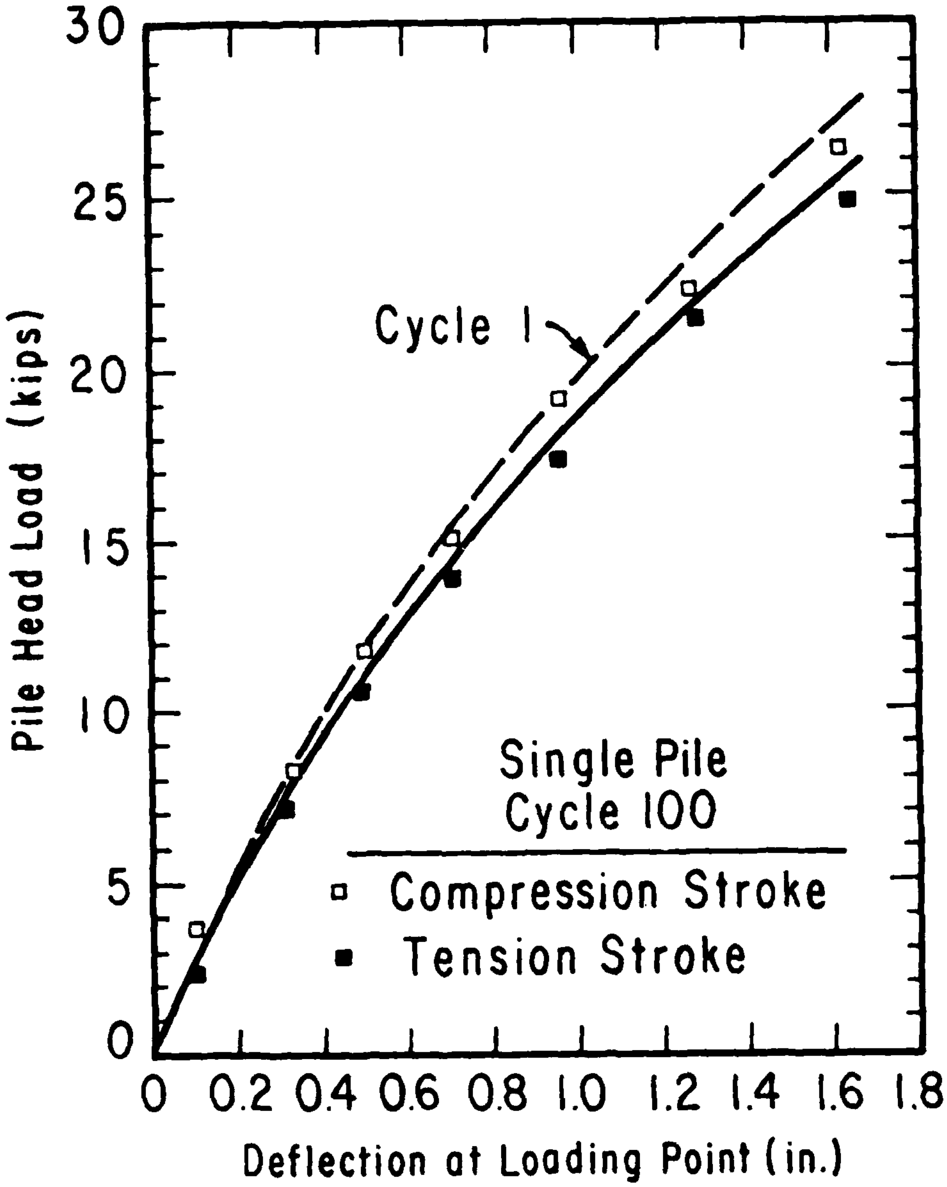



Fig. 5.4. Load-deflection curves for single pile for cycle 100.

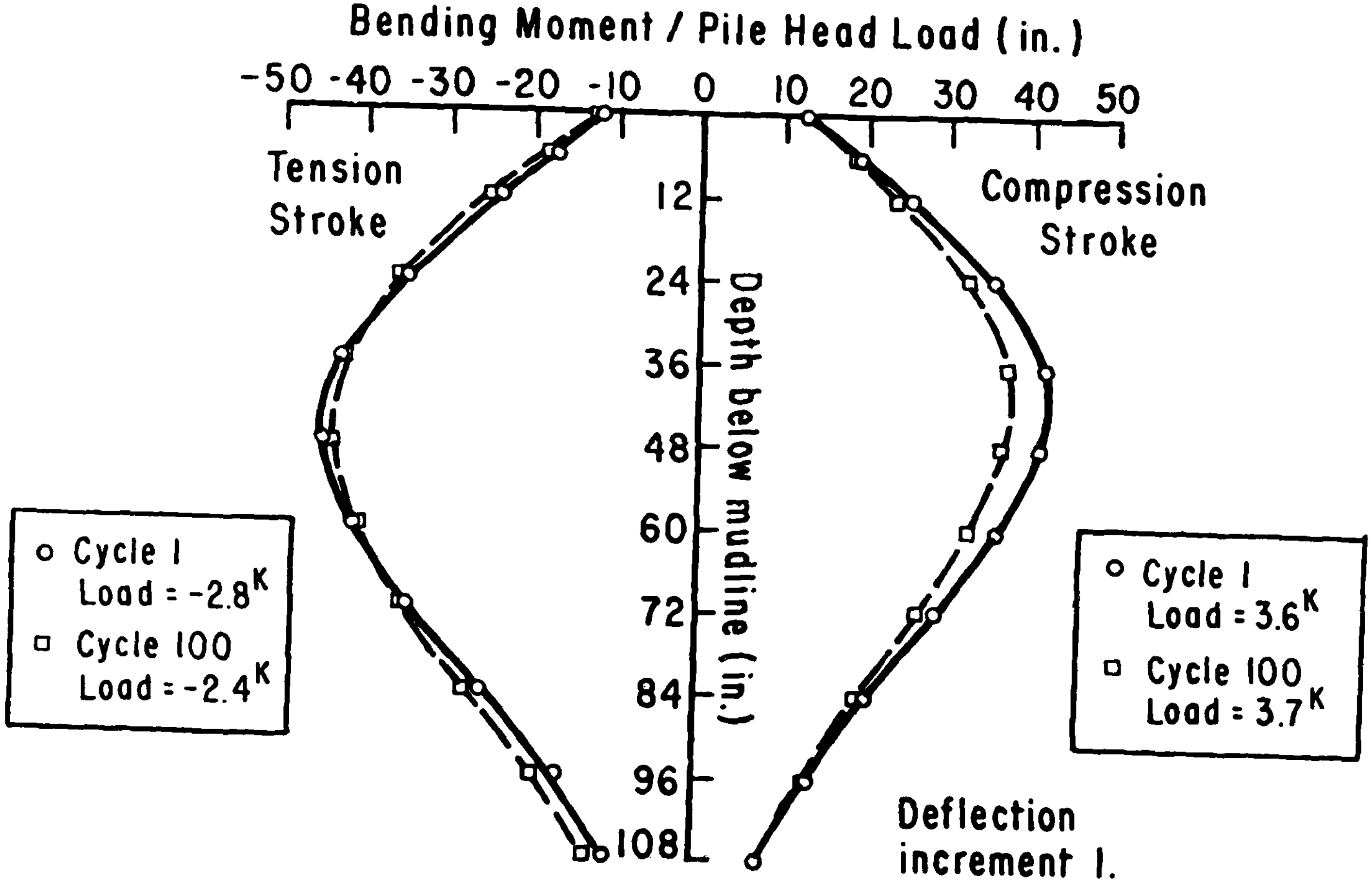



Fig. 5.5. Normalized moment curves for single pile for first deflection increment.

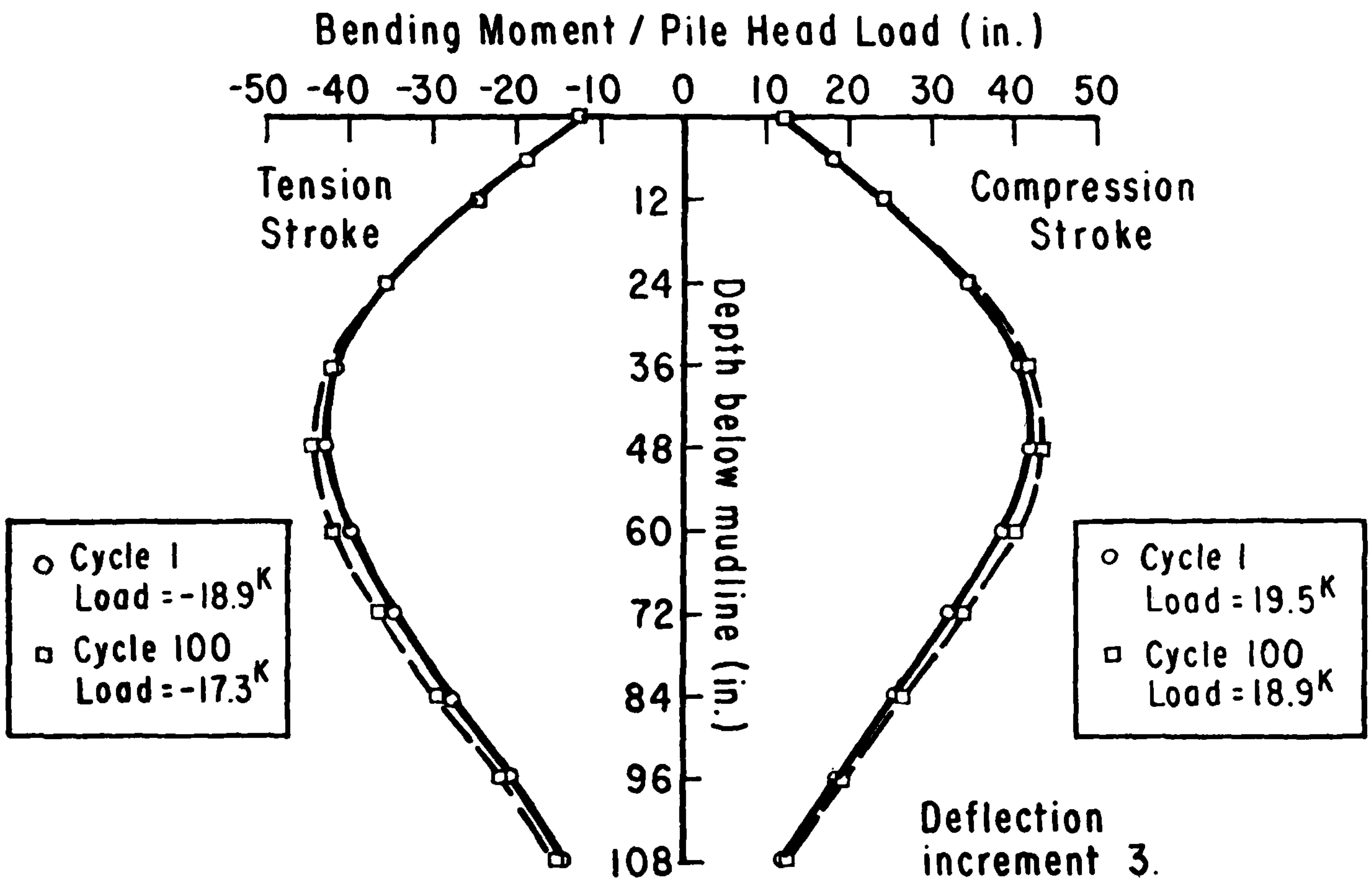



Fig. 5.6. Normalized moment curves for single pile for third deflection increment.

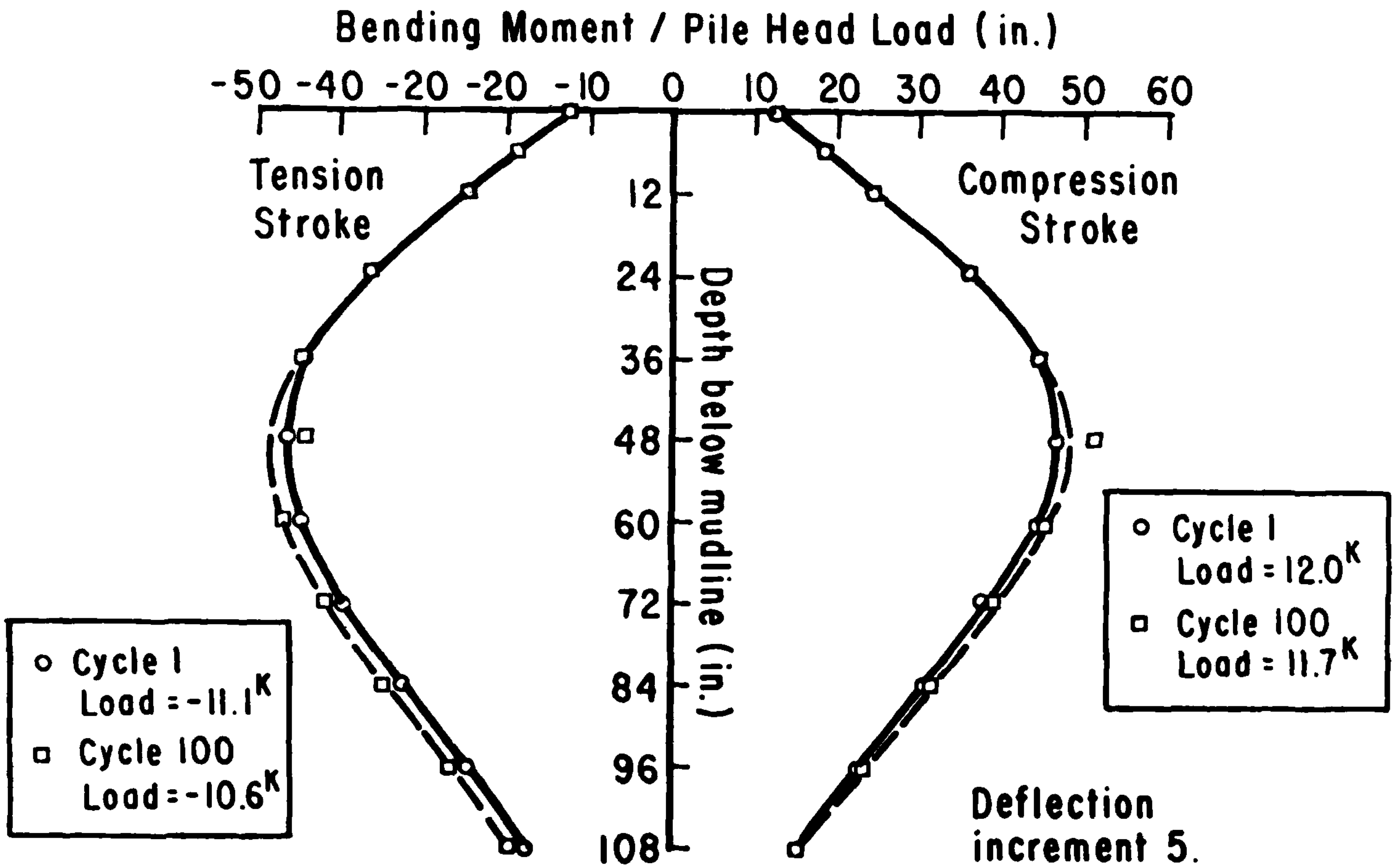



Fig. 5.7. Normalized moment curves for single pile for fifth deflection increment.

to densify and the soil response to become stiffer. For the third and fifth deflections the maximum normalized moment is larger for cycle 100 than for cycle 1. This implies that cycling larger deflections causes the sand to loosen and the soil response to become softer.

**Load versus Maximum Moment**

The relationship between pile-head load and maximum bending moment in the pile is shown in Fig. 5.8 for both cycle 1 and cycle 100. For higher loads, the maximum moment for cycle 100 is higher than for cycle 1. This is consistent with the normalized curves discussed in the previous paragraph.

**Soil Response**

The soil pressure (soil resistance) at a point along a pile can be obtained from the second derivative of the moment curve. The deflection at any point along a pile can be obtained by integrating the moment curve twice, using the pile-head slope and deflection as integration constants. These relationships are given mathematically by the following two equations.

$$p = \frac{d^2M(z)}{dz^2} \tag{5.1}$$

$$y = \frac{1}{EI} \iint M(z)dz \tag{5.2}$$

where z = distance below loading point,

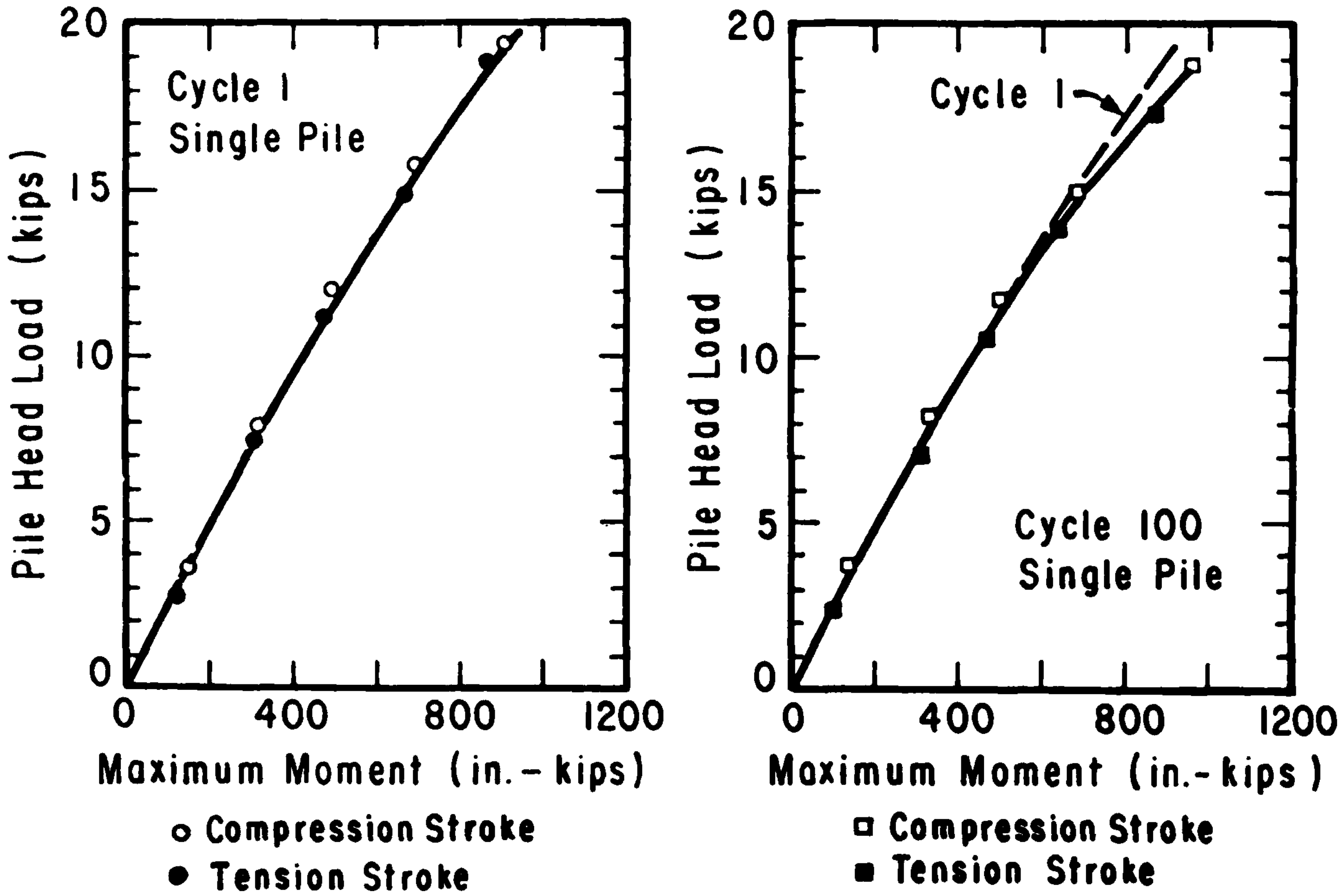



Fig. 5.8. Pile-head load vs. maximum moment for single pile.

$M(z)$ = bending moment as a function of depth,

$EI$ = flexural rigidity,

$p$ = soil resistance per unit length of pile, and

$y$ = lateral deflection of the pile.

In order to apply Eqs. 5.1 and 5.2 to the measured data, a polynomial function was fitted to the measured bending moments using the method of least squares. The polynomial was then integrated twice to obtain the deflection and differentiated twice to obtain soil resistance. To obtain the deflection and soil resistance at a given gauge level, a third-degree polynomial was fitted through seven points. Where possible, the gauge level at which deflection and soil resistance were to be determined was the middle gauge of the seven used for curve fitting. Where this was not possible (near the top and bottom of the instrumented section), the gauge under consideration was placed as close to the middle as possible. As an example, to obtain p-y data for gauge level 3 (depth = 12 in. below mudline) a polynomial was fitted to the loading point and the moments measured at gauge level 1 through 6, corresponding to depths of -12 in. to 48 inches. Because the polynomial is fitted to points extending 36 in. below gauge level 3, but only 24 in. above it, the generated p-y data might be

expected to be somewhat stiffer than the "true" p-y data. Similarly for gauge levels near the bottom of the instrumented section, generated p-y data might be expected to be softer than the "true" p-y data.

The measured p-y curves for gauges 3 through 8, representing depths of 12 in. to 72 in., are shown in figs. 5.9, 5.10, and 5.11. Curves are presented for both cycle 1 and cycle 100. The p-y curves become stiffer with increasing depth. For depths of 12 in. to 36 in. the p-y curve for cycle 100 is softer than for cycle 1. Below 36 in. cycling has little or no effect on the p-y curve.

The measured p-y curves are compared with calculated p-y curves in Figs. 5.12, 5.13, and 5.14. One set of p-y curves was generated according to the procedure of Reese, Cox, and Koop (1975). This set of curves is labelled RCK in Figs. 5.12 through 5.14. Another set of p-y curves was calculated using a modified procedure in which the soil resistances from the procedure of Reese, Cox, and Koop were multiplied by 1.55. This set of curves is labelled MRCK in Figs. 5.12 through 5.14. The p-y curves generated by the modified procedure were then used with program COM 624 to calculate deflections and maximum moments for a pile with the properties of the pile used in the load test. The deflections and moments calculated in this manner are compared with the measured values in

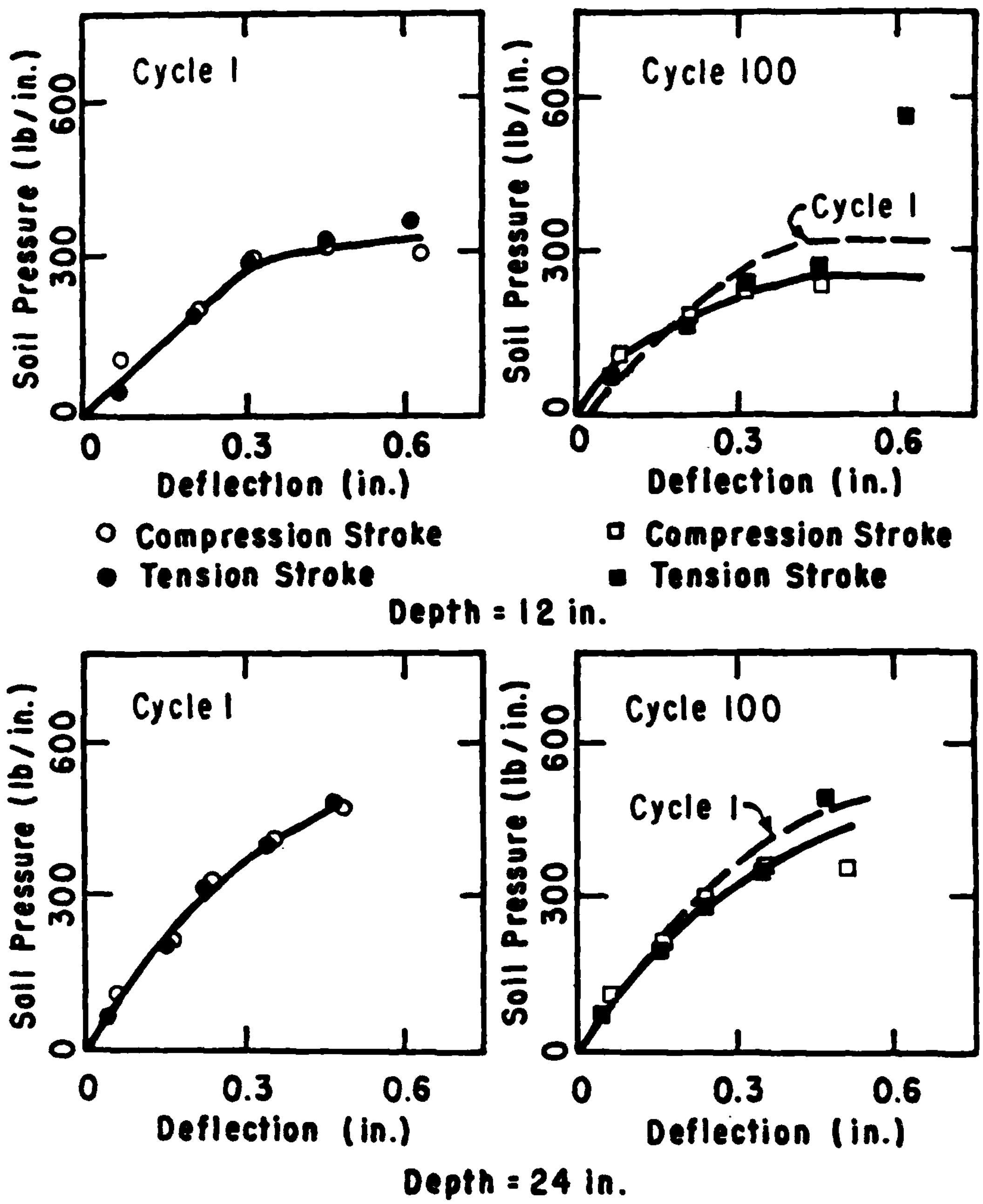



Fig. 5.9. Experimental p-y curves for depths of 12 in. and 24 in. for single pile.

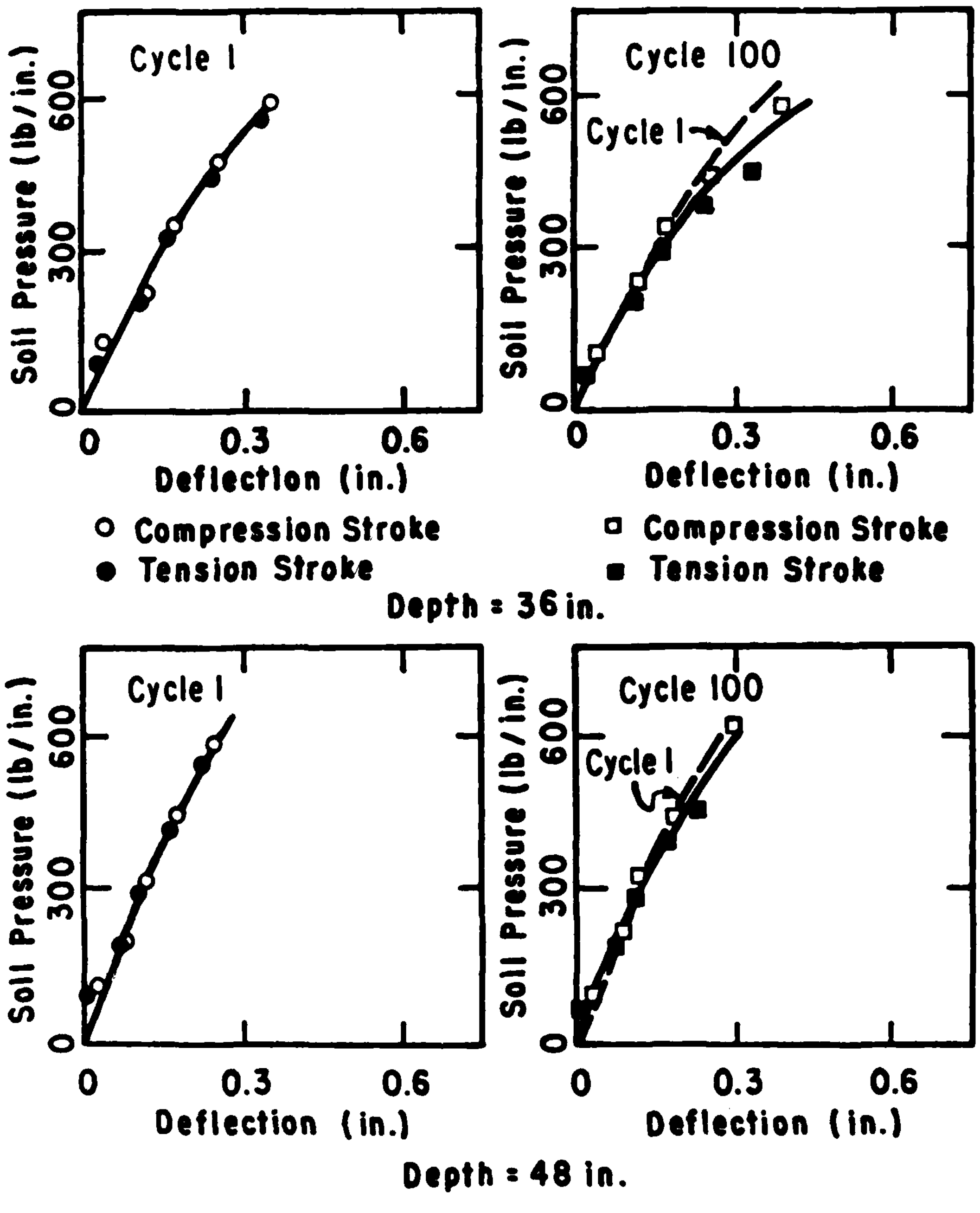



Fig. 5.10. Experimental p-y curves for depths of 36 in. and 48 in. for single pile.

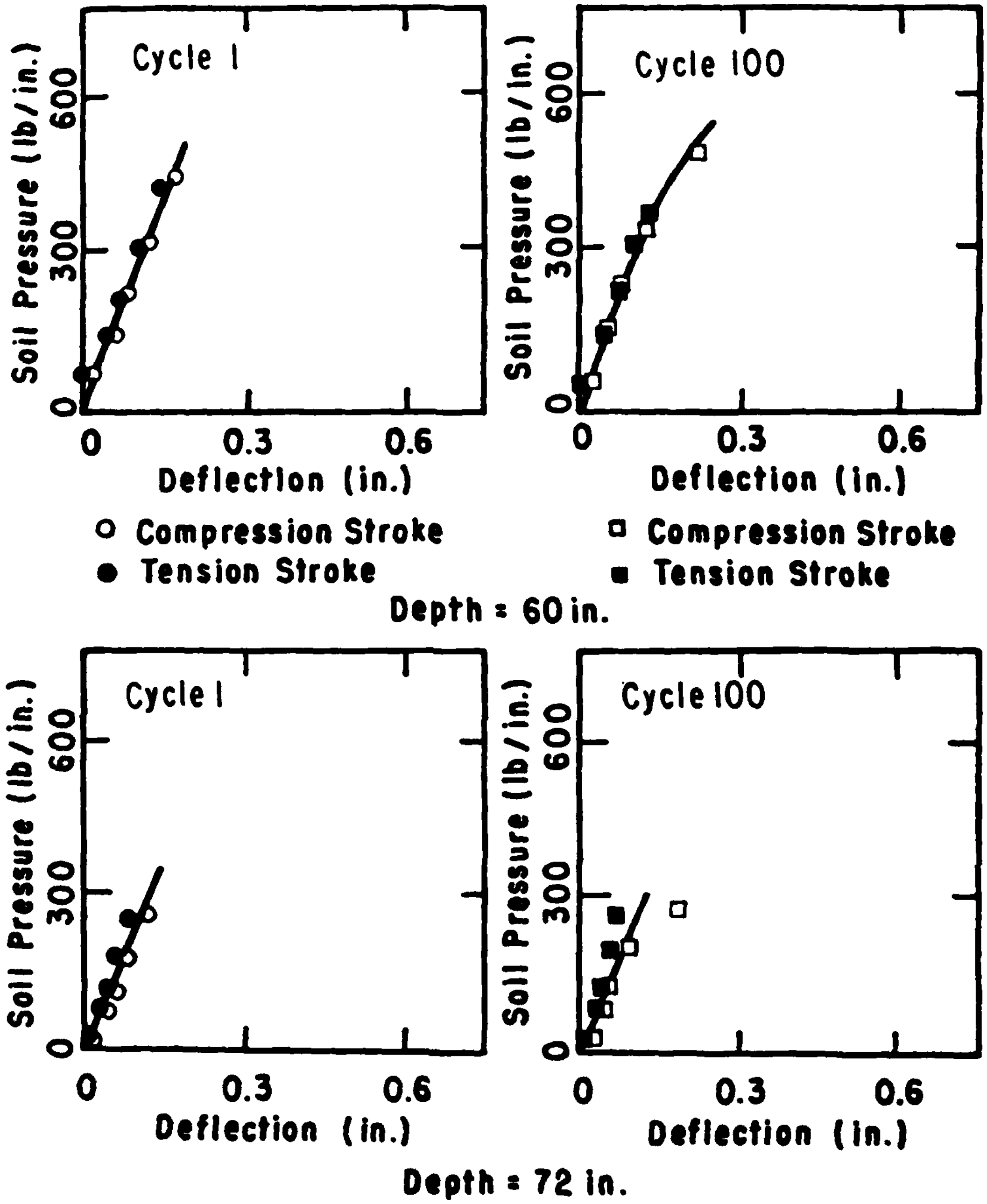



Fig. 5.11. Experimental p-y curves for depths of 60 in. and 72 in. for single pile.

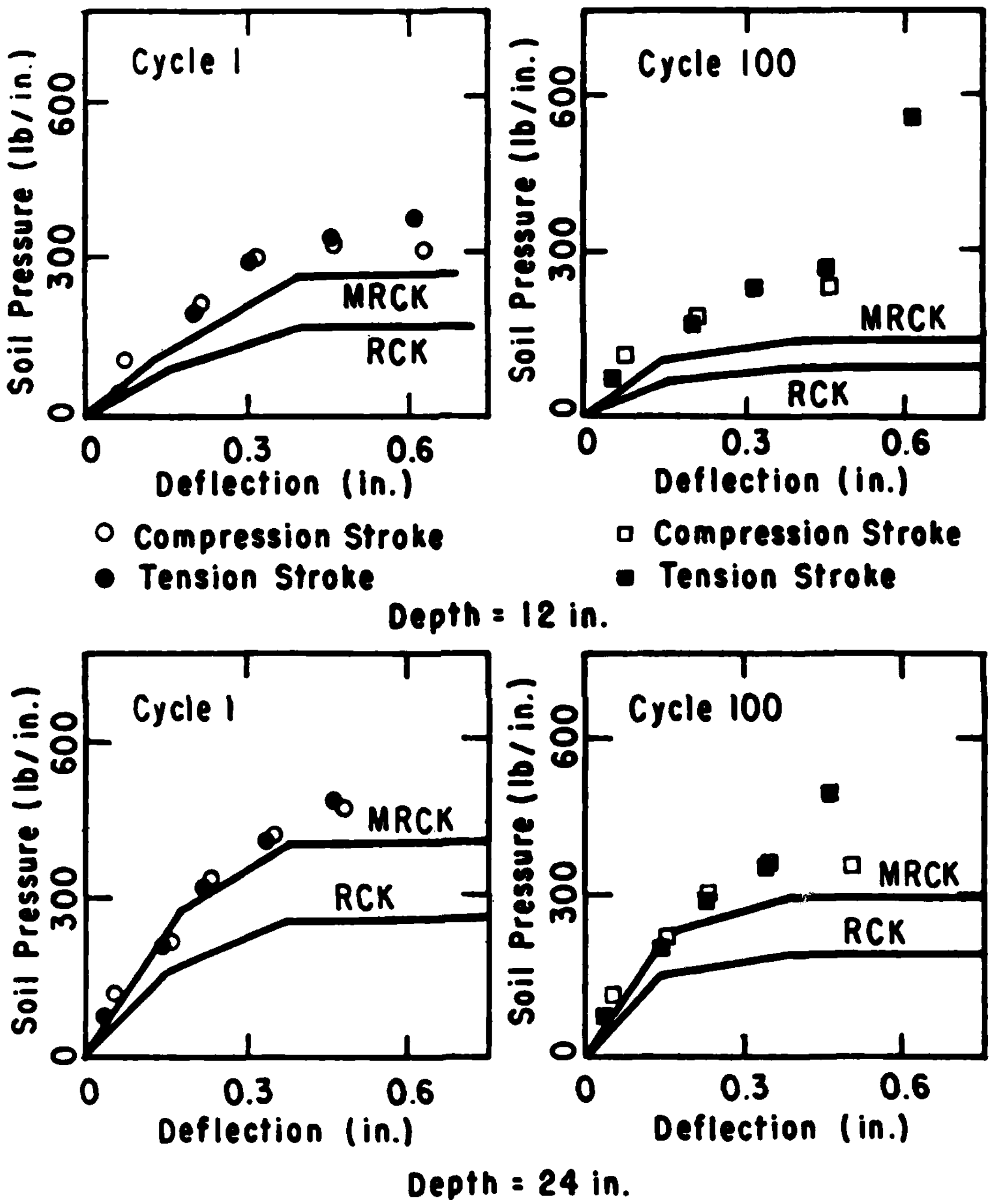



Fig. 5.12. Comparison of experimental and computed p-y curves for single pile.

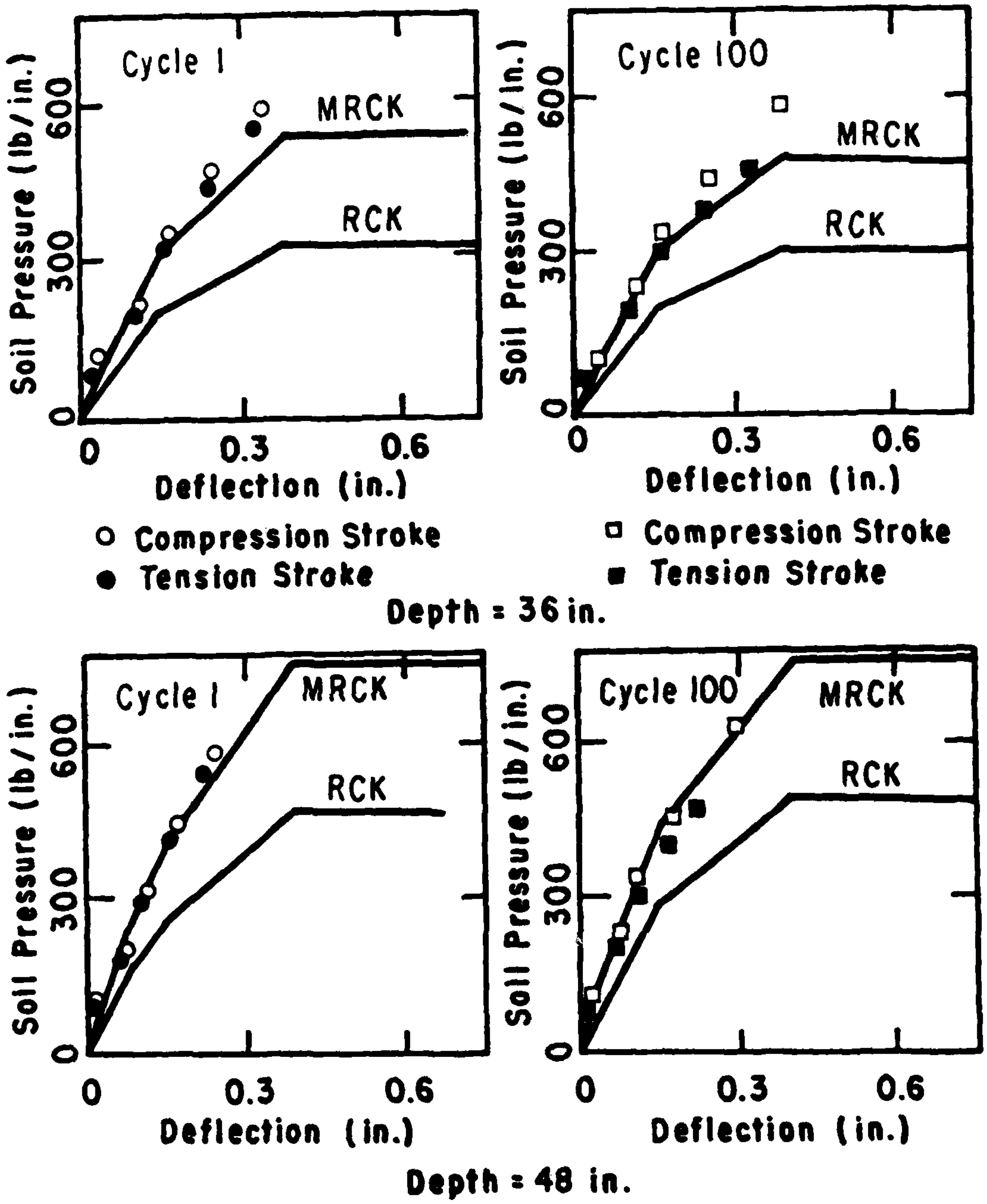



Fig. 5.13. Comparison of experimental and computed p-y curves for single piles.

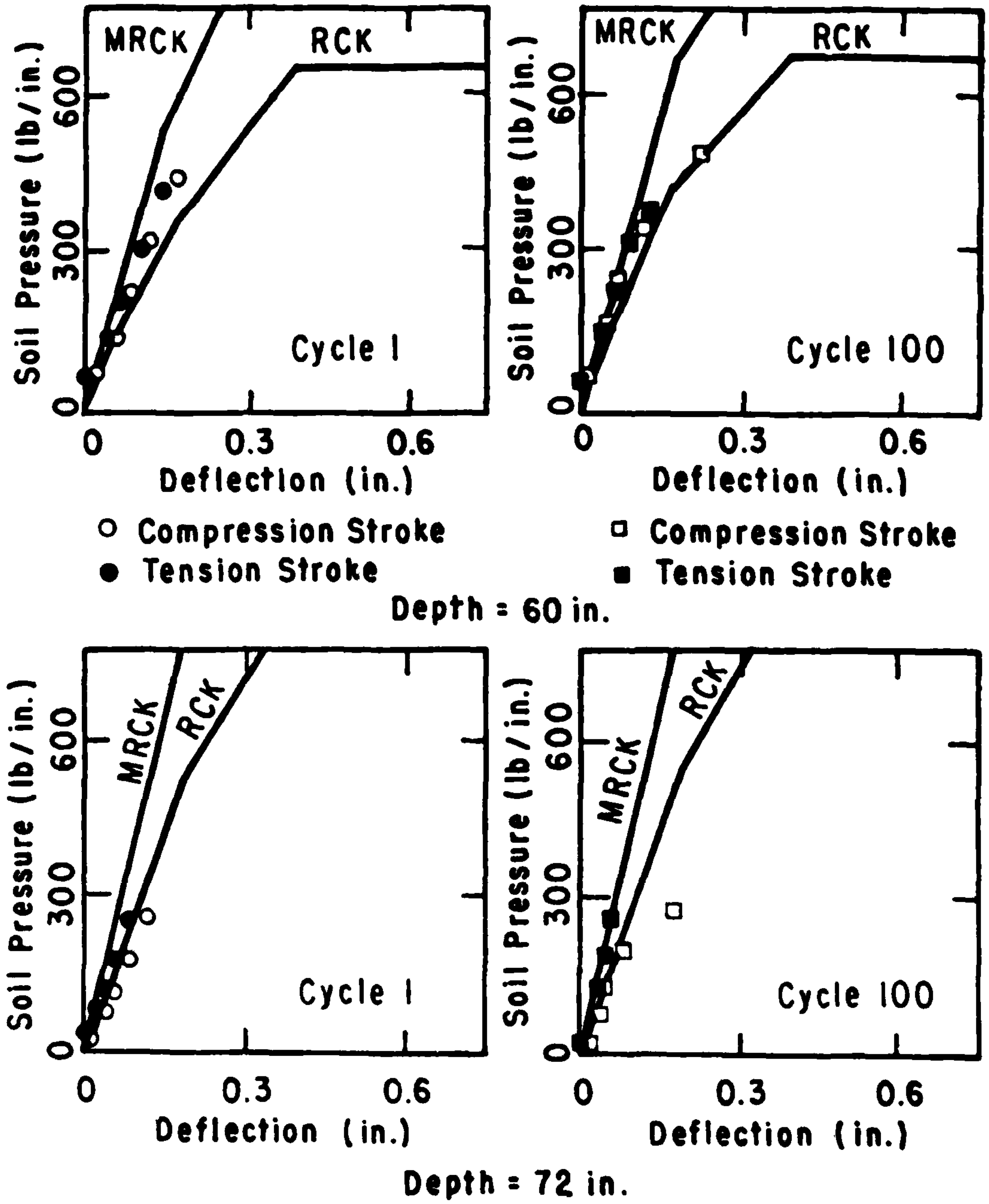



Fig. 5.14. Comparison of experimental and computed p-y curves for single pile.

Figs. 5.15 and 5.16. It is believed that the p-y curves generated by the modified procedure adequately model the response of the soil for the single-pile load test.

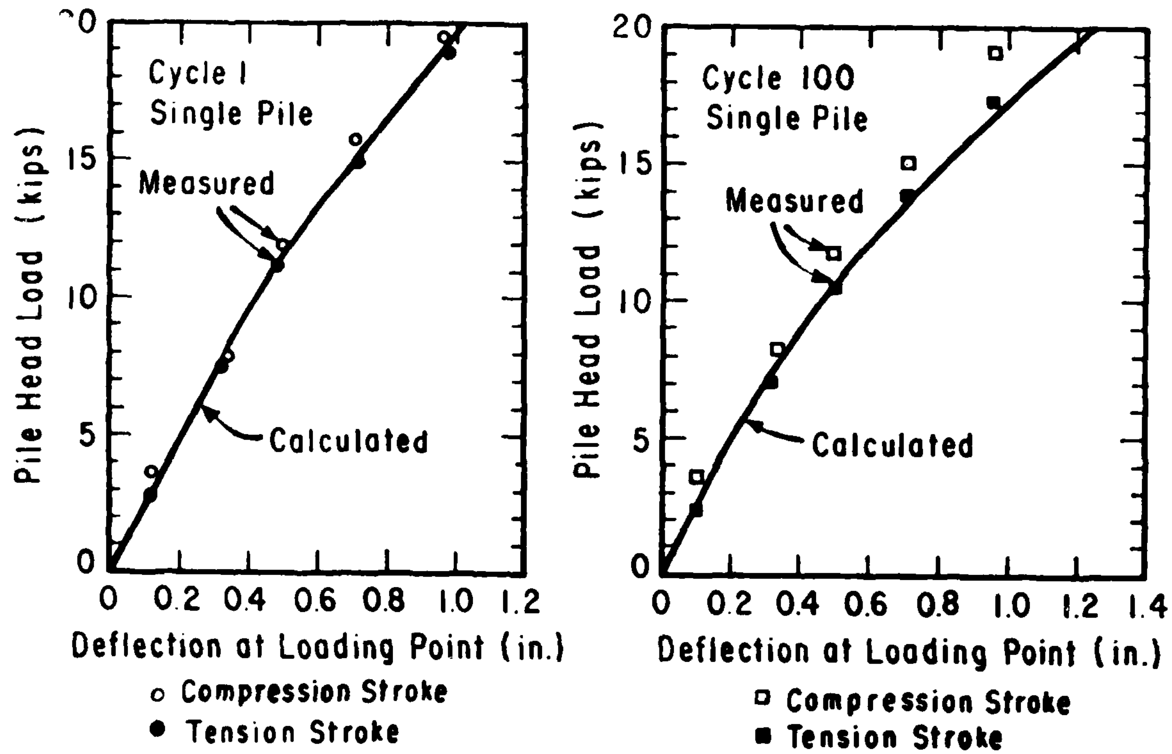
## RESULTS OF LOAD TEST OF PILE GROUP

### Dependency of Pile-Head Load on Cycling

A number of cycles of each deflection increment was applied to the pile group. Each cycle consisted of applying the deflection first to the north (referred to as the compression stroke since the loading apparatus was in compression) and then applying the same deflection to the south (referred to as the tension stroke). As mentioned in chapter 3, for the second and third deflection during the first attempt of the load test of the pile group, the order was reversed. The measured average pile head loads and corresponding average load-point deflections for the compression strokes are shown in Fig. 5.17. Those for the tension stroke are shown in Fig. 5.18. For the compression stroke, the pile-head load only changed slightly as additional cycles were applied. For the tension stroke, the load decreased substantially after the first cycle.

### Pattern of Deflection of the Pile Group

During the load tests, the same deflection was not imposed on all of the piles. As the test progressed




...mparison of computed and measured deflections for the single pile.

AD-A194 216 A LATERIAL-LOAD TEST OF A FULL-SCALE PILE GROUP IN SAND 2/4
(U) TEXAS UNIV AT AUSTIN GEOTECHNICAL ENGINEERING
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UNCLASSIFIED DACW39-83-C-0061 F/G 13/13 NL


1.0
1.1
1.2
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1.6
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2.2
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3.2
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4.0

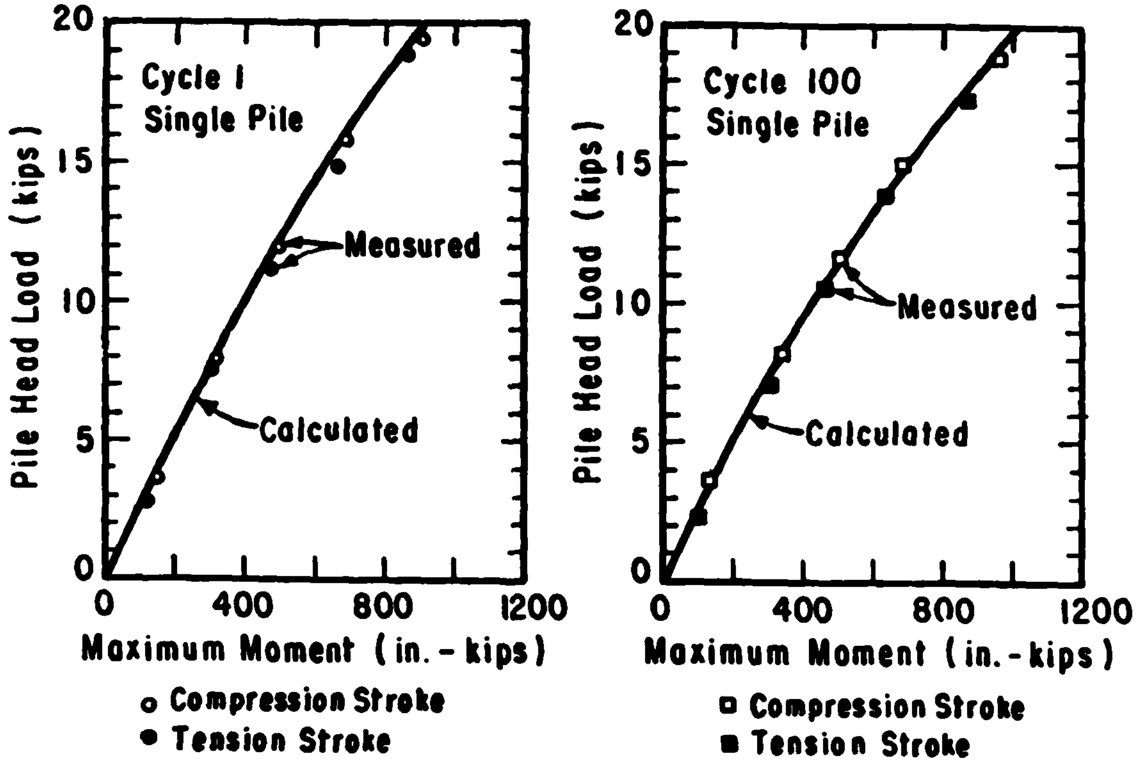


Fig. 5.16. Comparison of computed and measured maximum bending moment for the single pile.

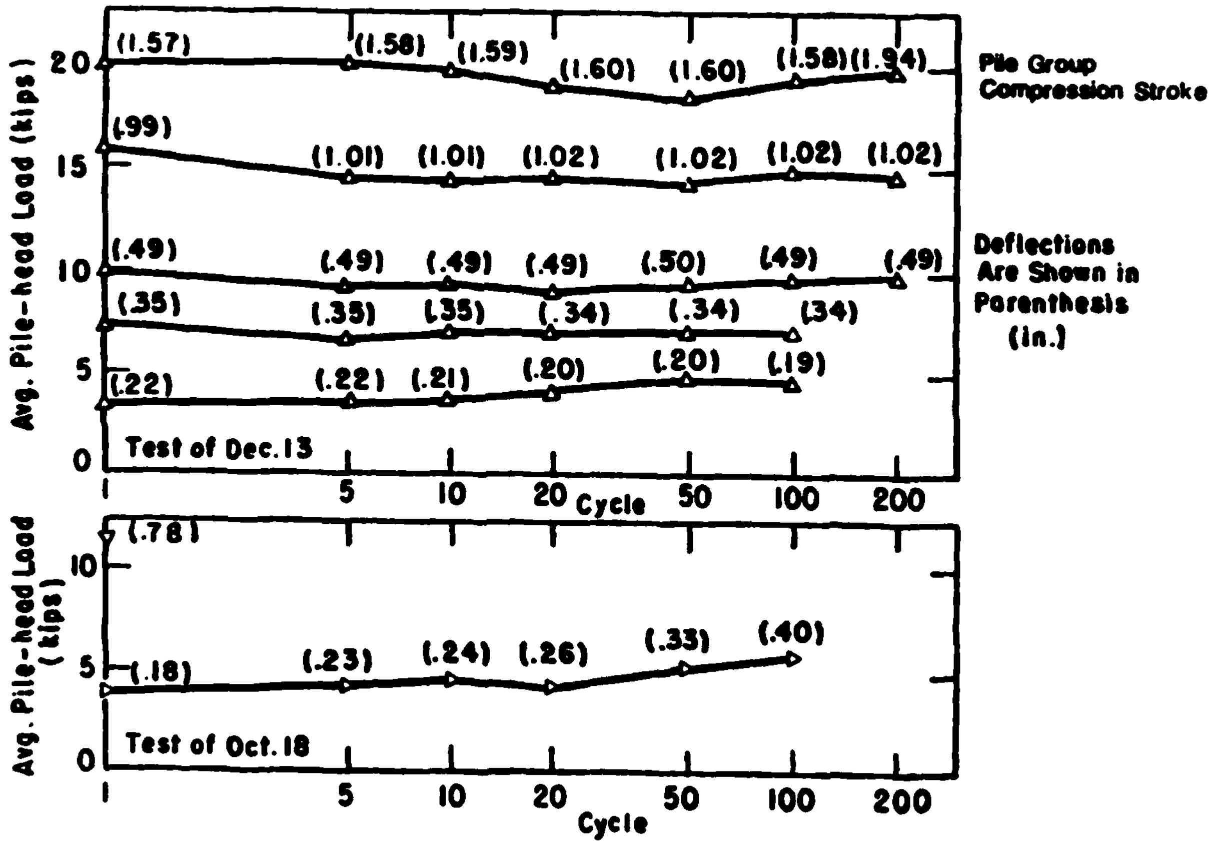


Fig. 5.17. Loads and deflections applied on compression stroke of cycle, pile-group test.

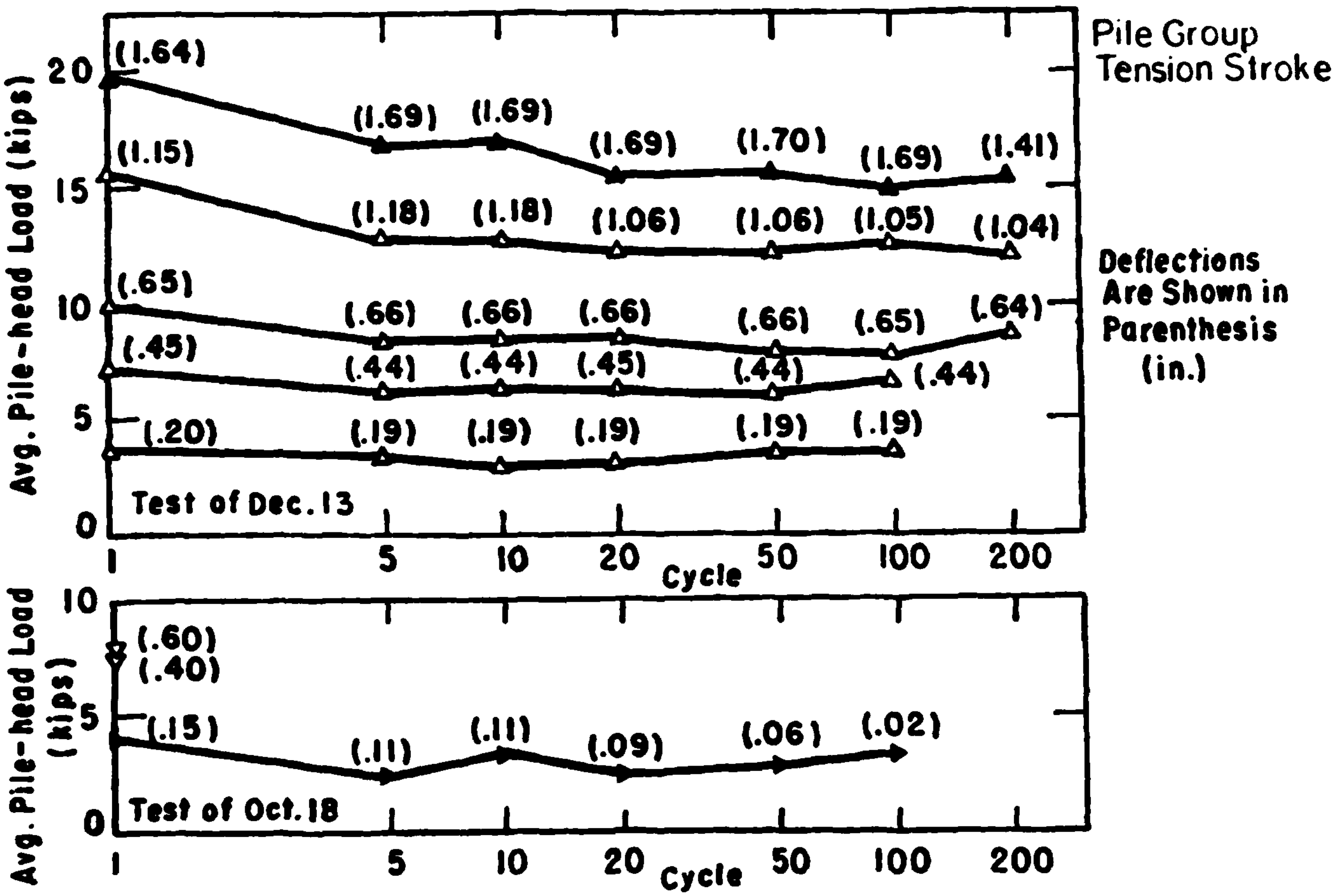


Fig. 5.18. Loads and deflections applied on tension stroke of cycle, pile-group test.

the pile group rotated about a vertical axis. As the deflections were cycled, the heads of the piles in the group translated while maintaining the rotation. The deflection pattern is shown in Figs. 5.19 through 5.21. The rotation could not be corrected by moving the point of load application on the loading frame. The point of load application would have had to move east on the compression stroke and west on the tension stroke.

**Load Distribution**

The load applied to the loading frame was not distributed evenly among the piles. Typical load distributions are shown in Figs. 5.22 through 5.27. The leading row takes a larger portion of the total load than the middle row which in turn takes a larger portion than the trailing row. There is no clear pattern for the distribution of load to piles in a single row. Any pattern that may have been present would be obscured by the non-uniform pattern of deflection.

**Load versus Deflection**

The variation of average pile-head load with average deflection for cycle 1 of each deflection increment is shown in Fig. 5.28. Also shown in Fig. 5.28 is the variation of pile-head load with deflection for an isolated pile with properties similar to the piles in the group. This behavior was determined using program COM624

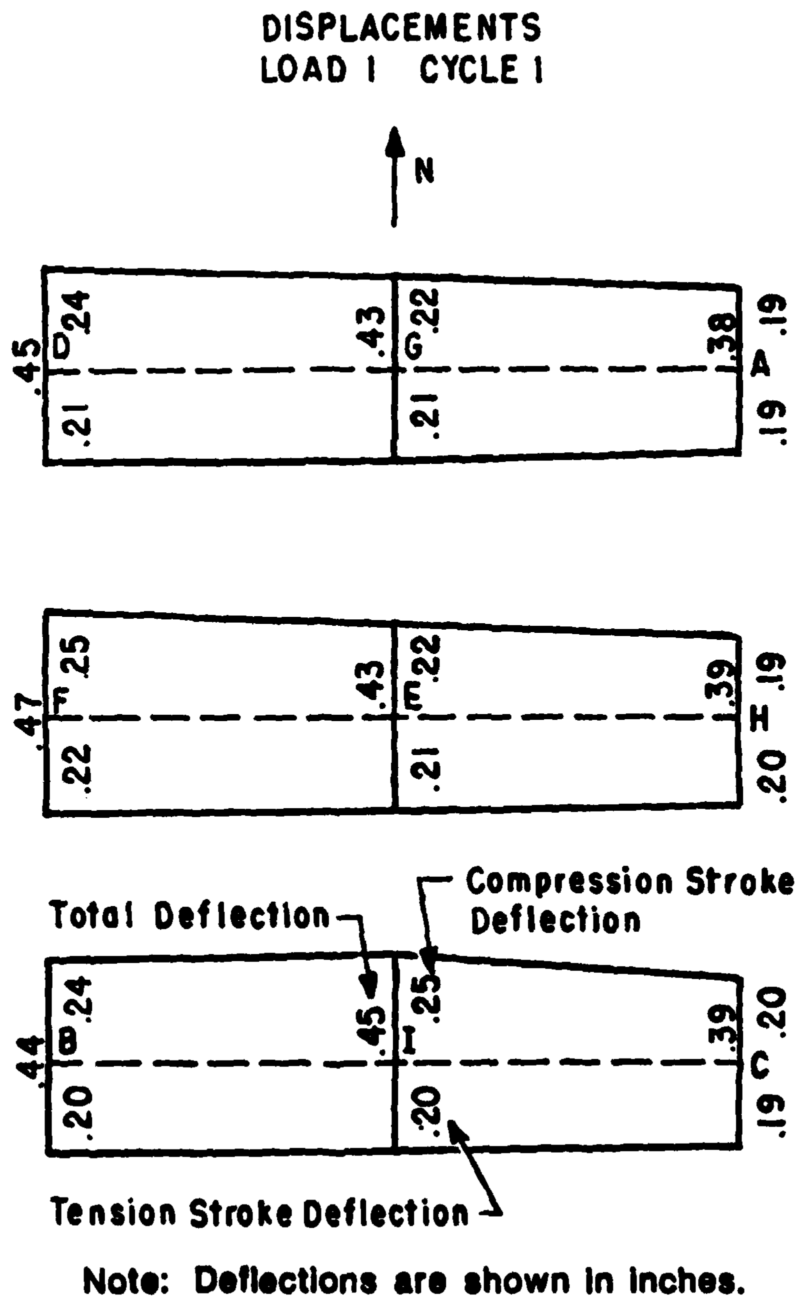


Fig. 5.19. Pattern of deflection for load 1, pile-group test.

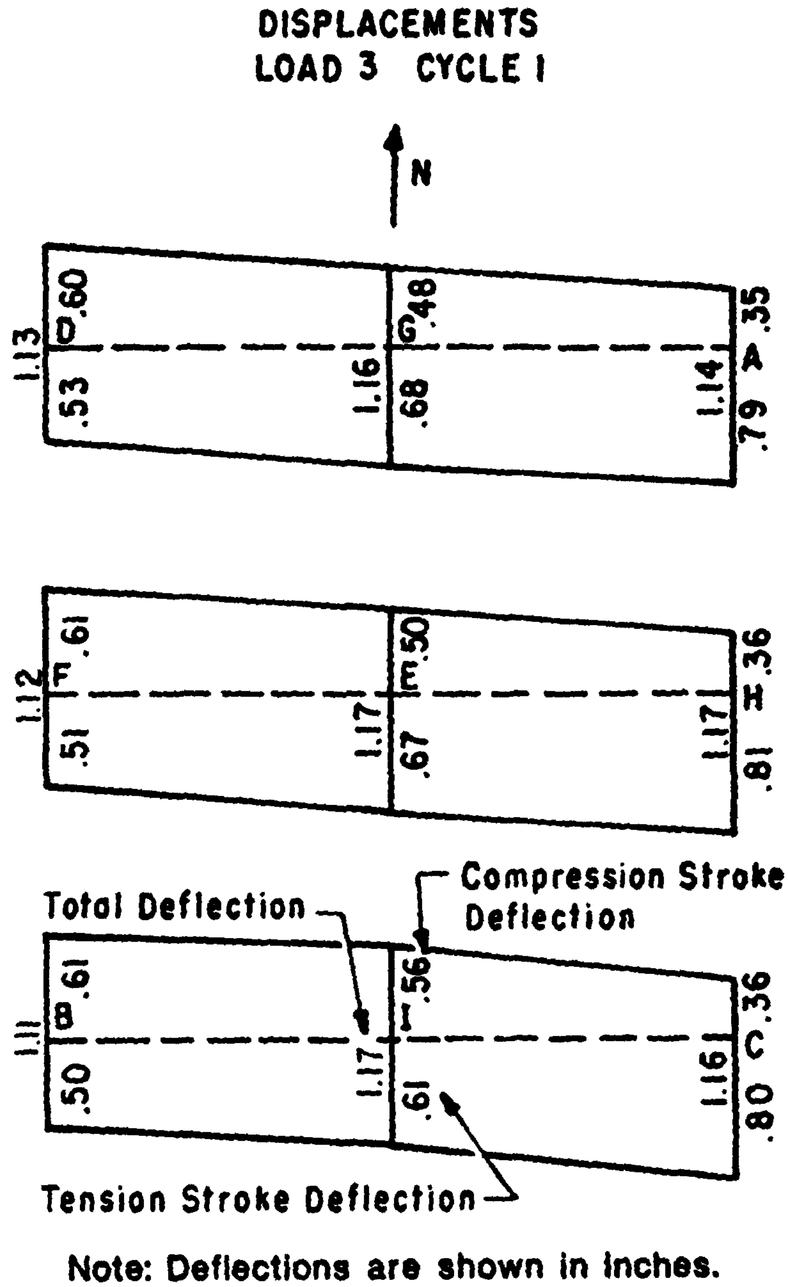


Fig. 5.20. Pattern of deflection for load 3, pile-group test.

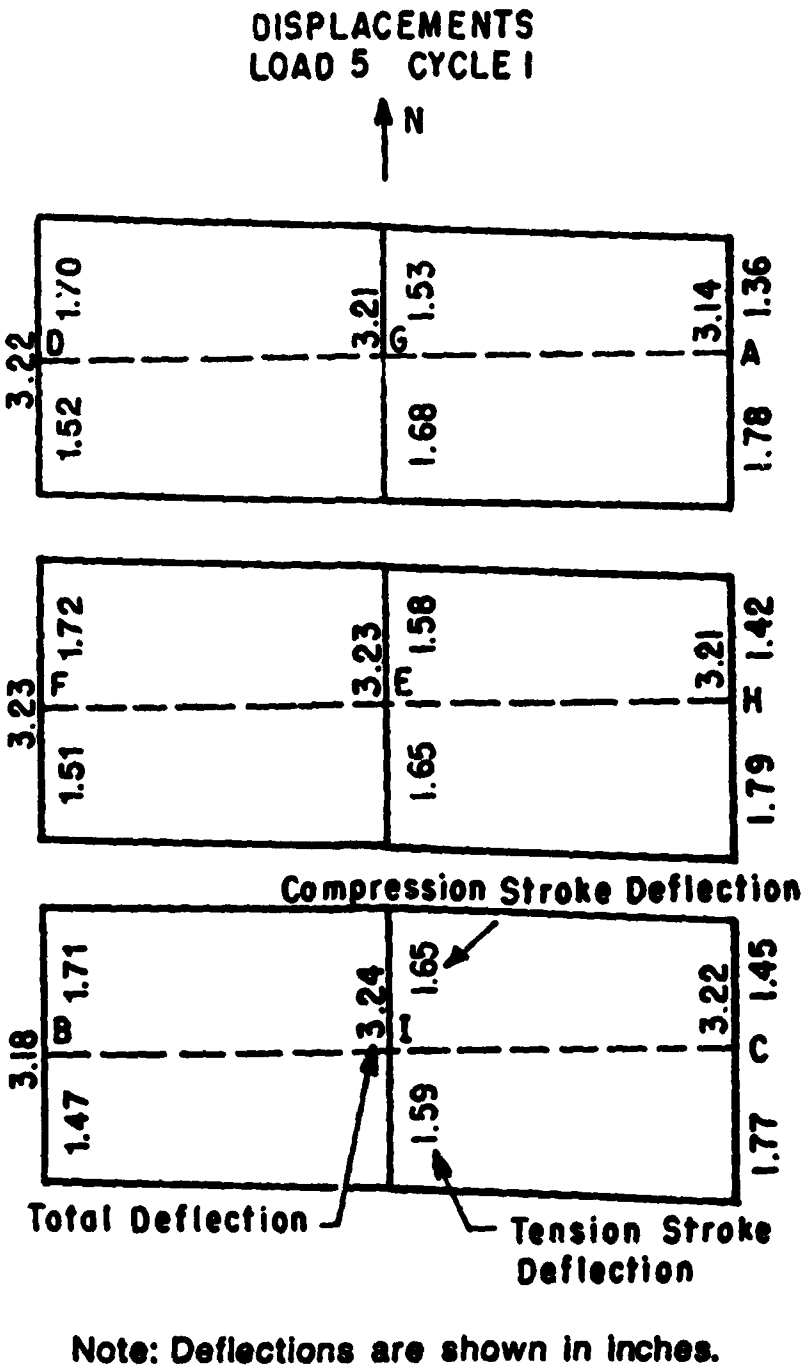


Fig. 5.21. Pattern of deflection for load 5, pile-group test.

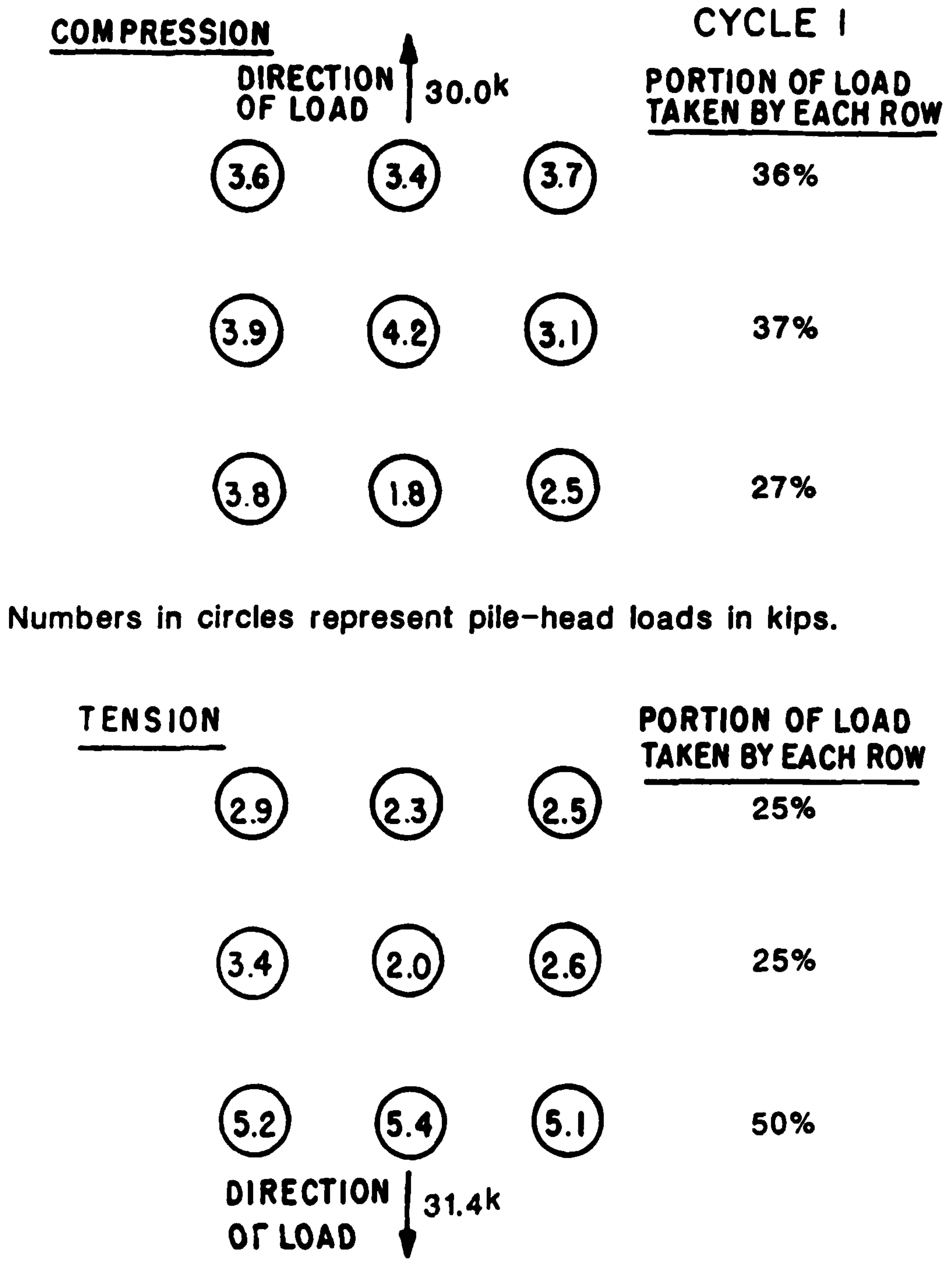


Fig. 5.22. Load distribution for load 1, cycle 1, pile-group test.

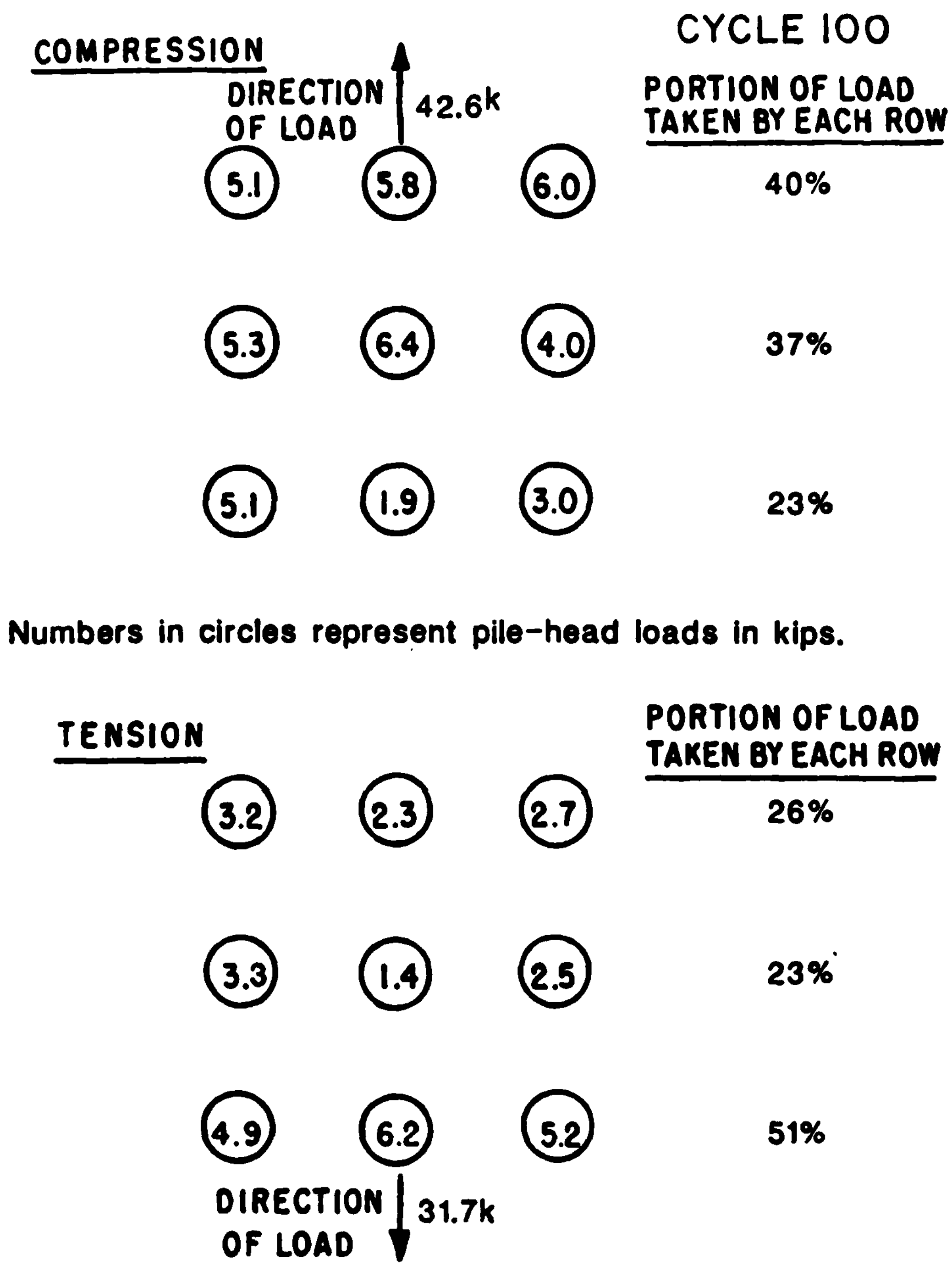


Fig. 5.23. Load distribution for load 1, cycle 100, pile-group test.

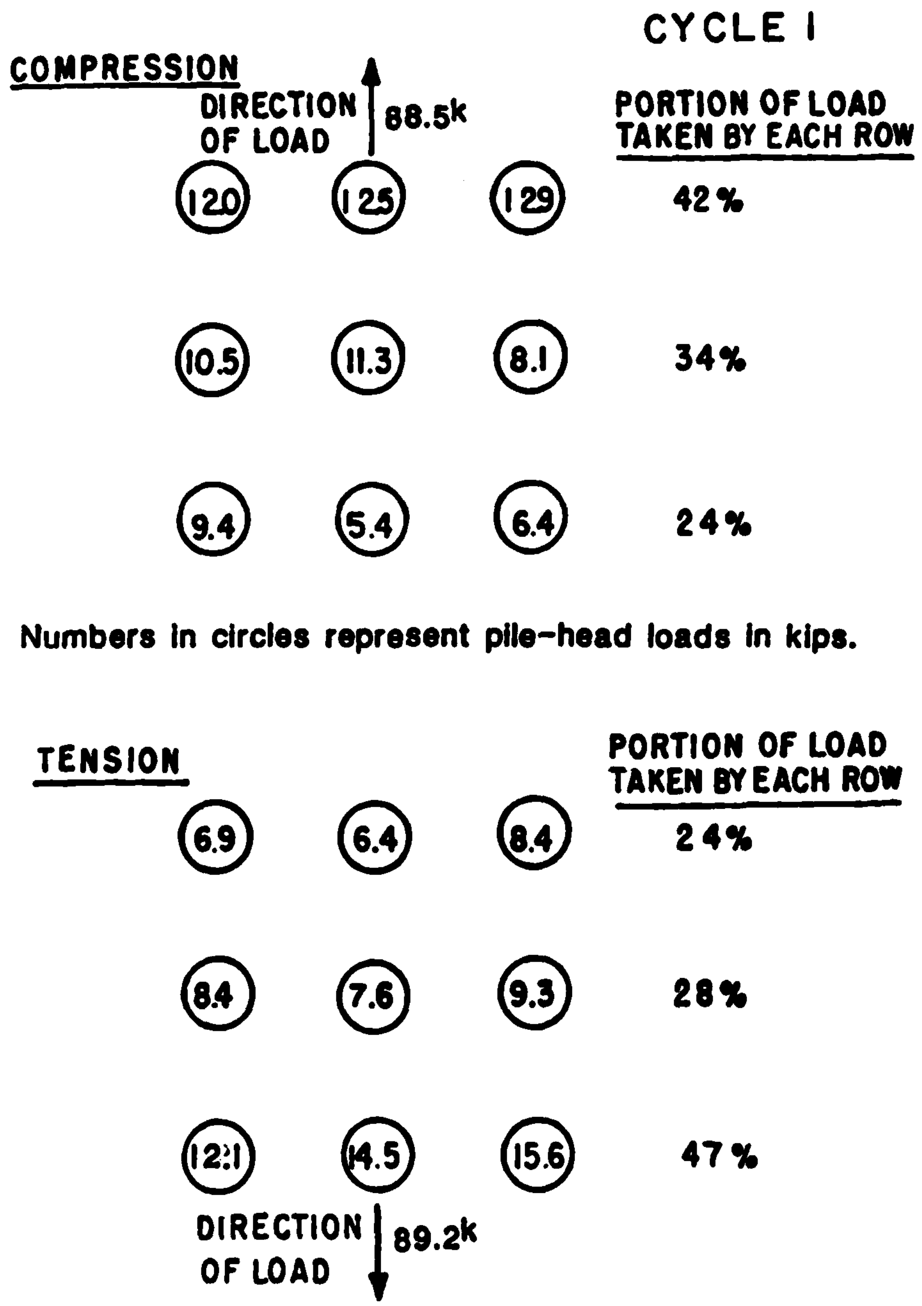


Fig. 5.24. Load distribution for load 3, cycle 1, pile-group test.

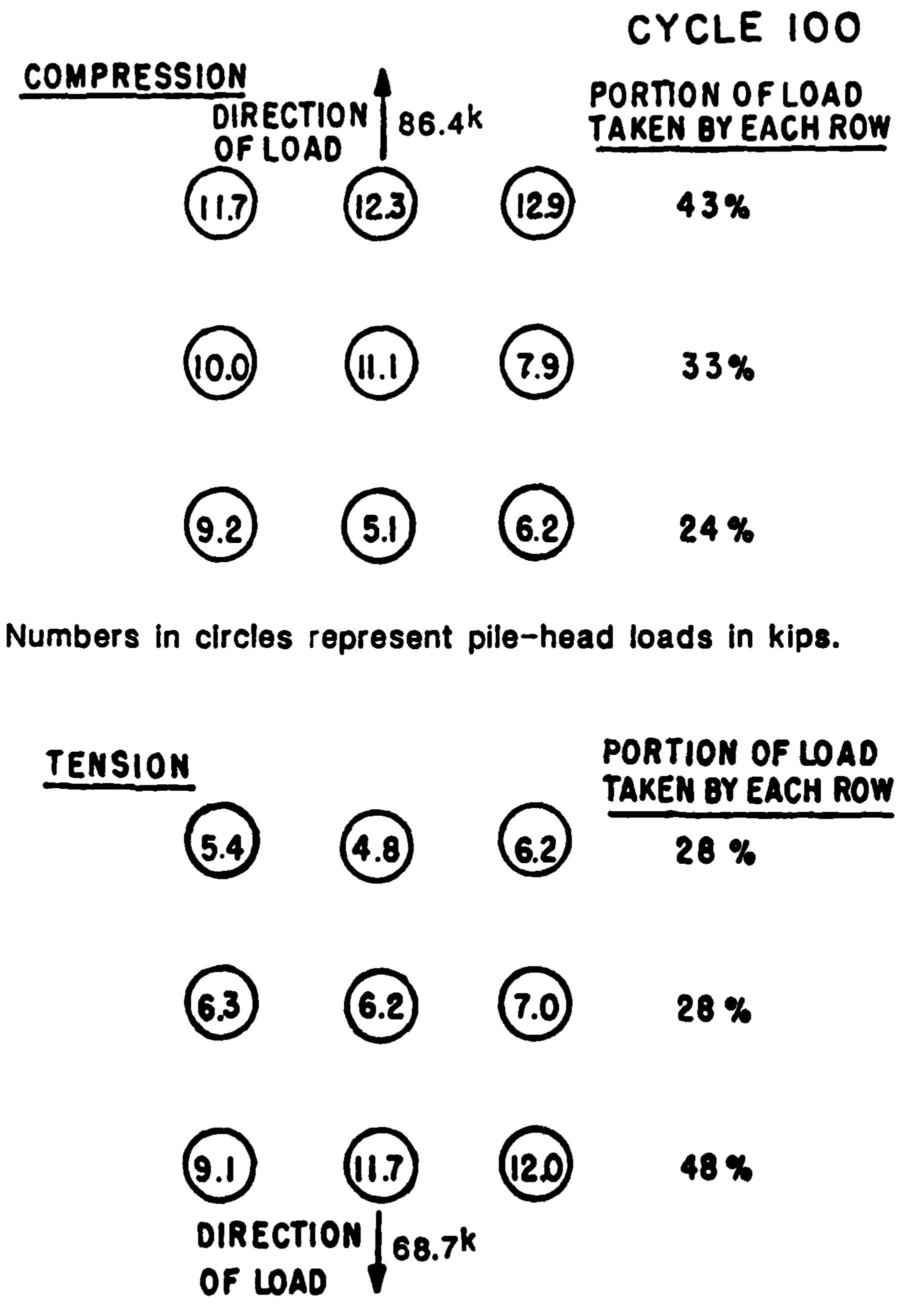


Fig. 5.25. Load distribution for load 3, cycle 100, pile-group test.

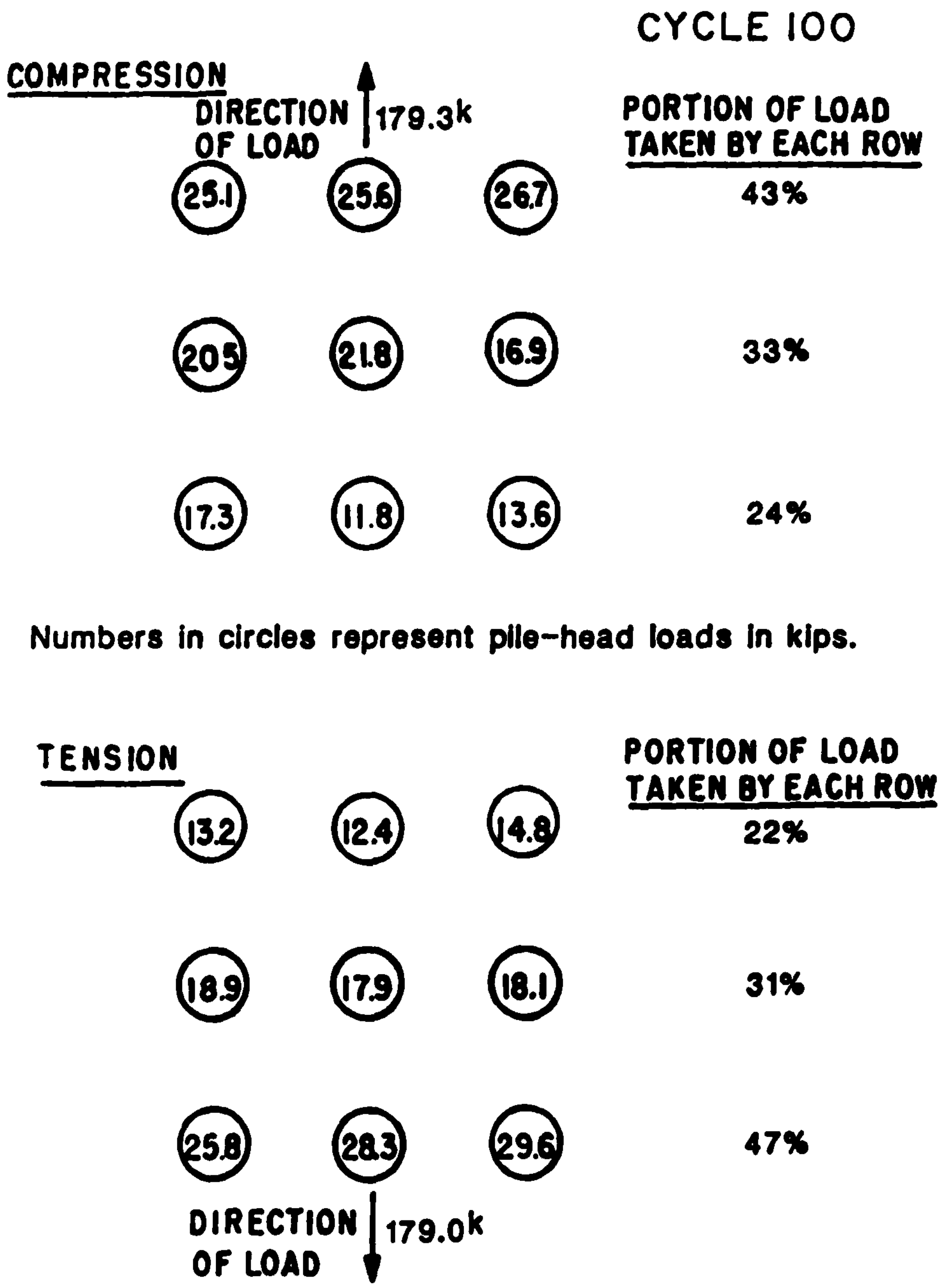


Fig. 5.26. Load distribution for load 5, cycle 1, pile-group test.

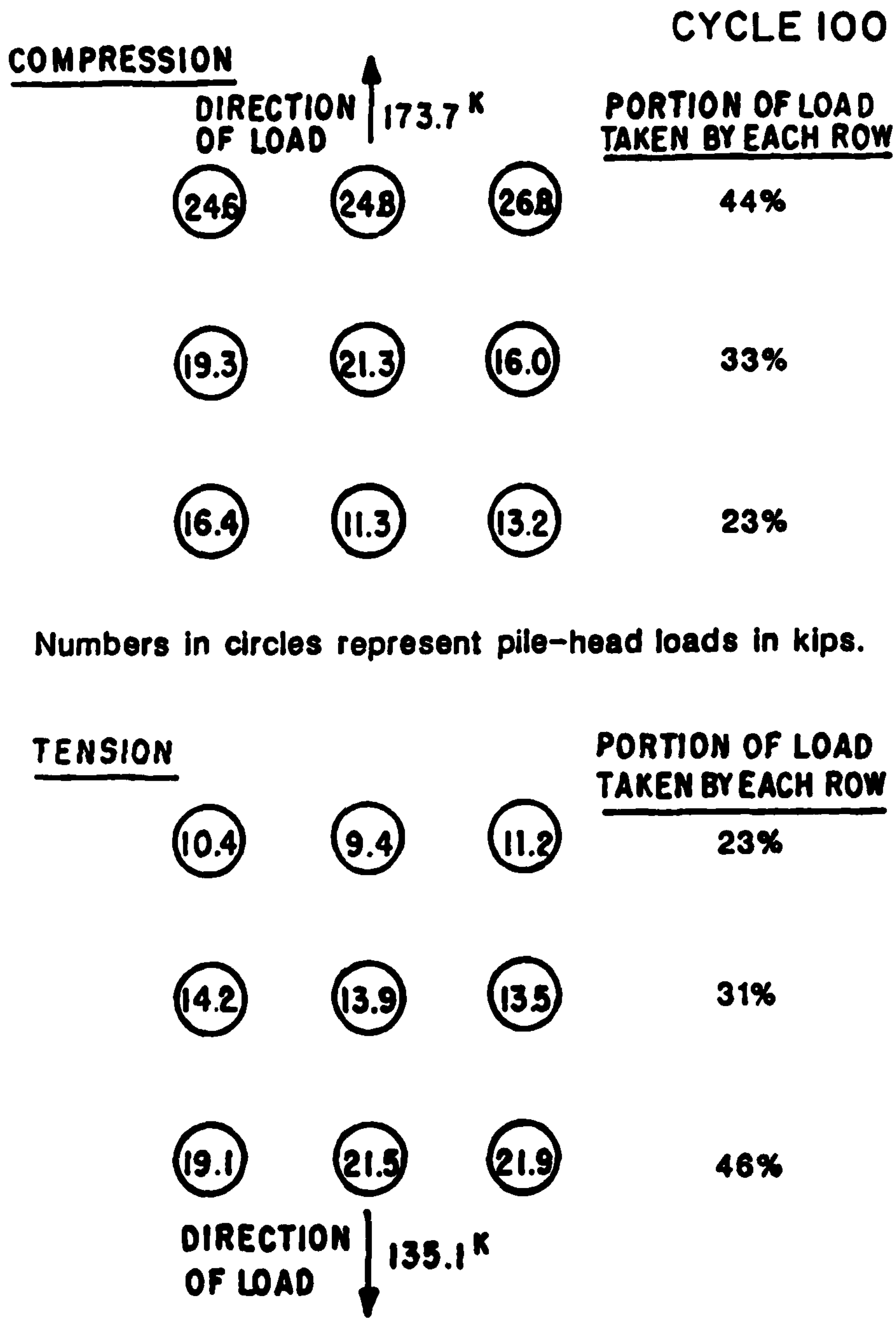


Fig. 5.27. Load distribution for load 5, cycle 100, pile-group test.

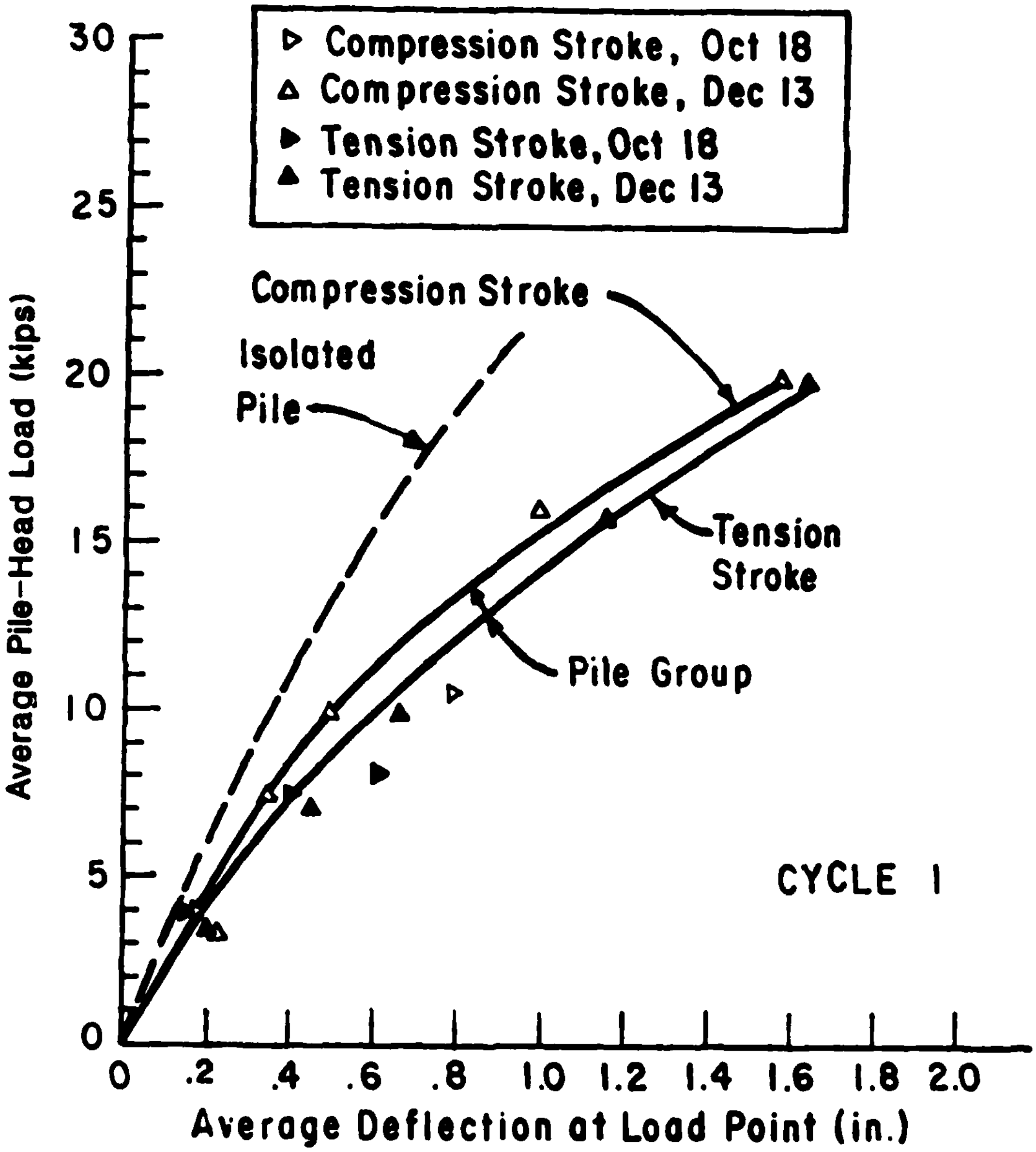


Fig. 5.28. Load-deflection curves for cycle 1, pile-group test.

and p-y curves generated by the modified procedure described earlier. For a given average load, the deflection of the pile group is larger than the deflection of a similar isolated pile. The pile group exhibits stiffer behavior on the compression stroke of the cycle than on the tension stroke.

The variation of average pile-head load with average pile-head deflection for cycle 100 of each deflection increment is shown in Fig. 5.29. Also shown is the load-deflection curve for an isolated pile with properties similar to the piles in the group. Again, for a given average load, the deflection of the group is larger than the deflection of an isolated pile. By comparing Figs. 5.28 and 5.29, it can be seen that the response of the pile group to load is softer at cycle 100 than at cycle 1. It can also be seen that the difference between the load-deflection curves for the tension and compression strokes is larger for cycle 100 than for cycle 1.

**Moment Curves**

Typical curves of bending moment versus depth for the pile group, as determined from the instrumentation, are shown in Figs. 5.30 through 5.33. The curves represent average moment for each row of piles. In all cases, moments are highest for the leading row of piles

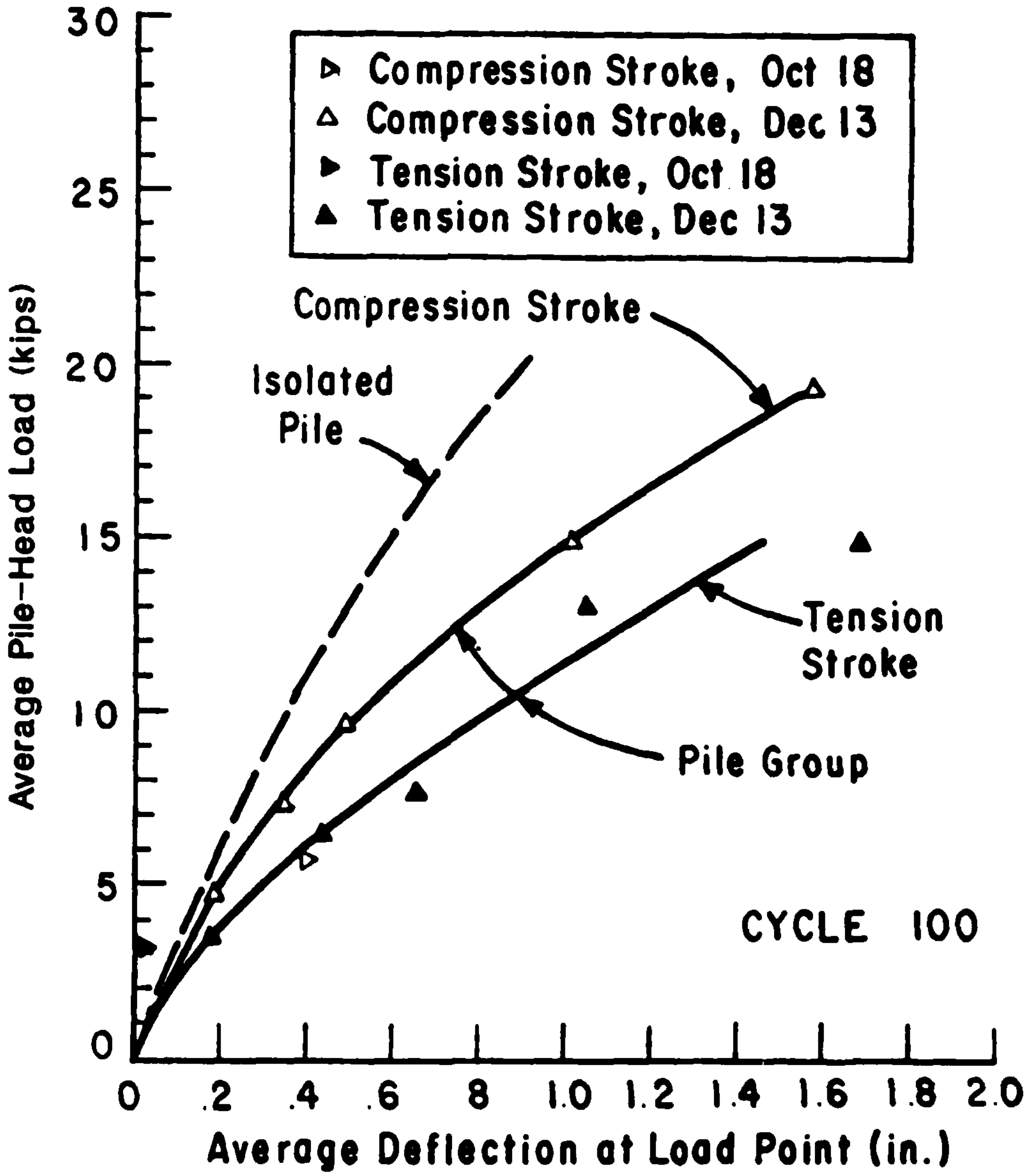


Fig. 5.29. Load deflection curves for cycle 100, pile-group test.

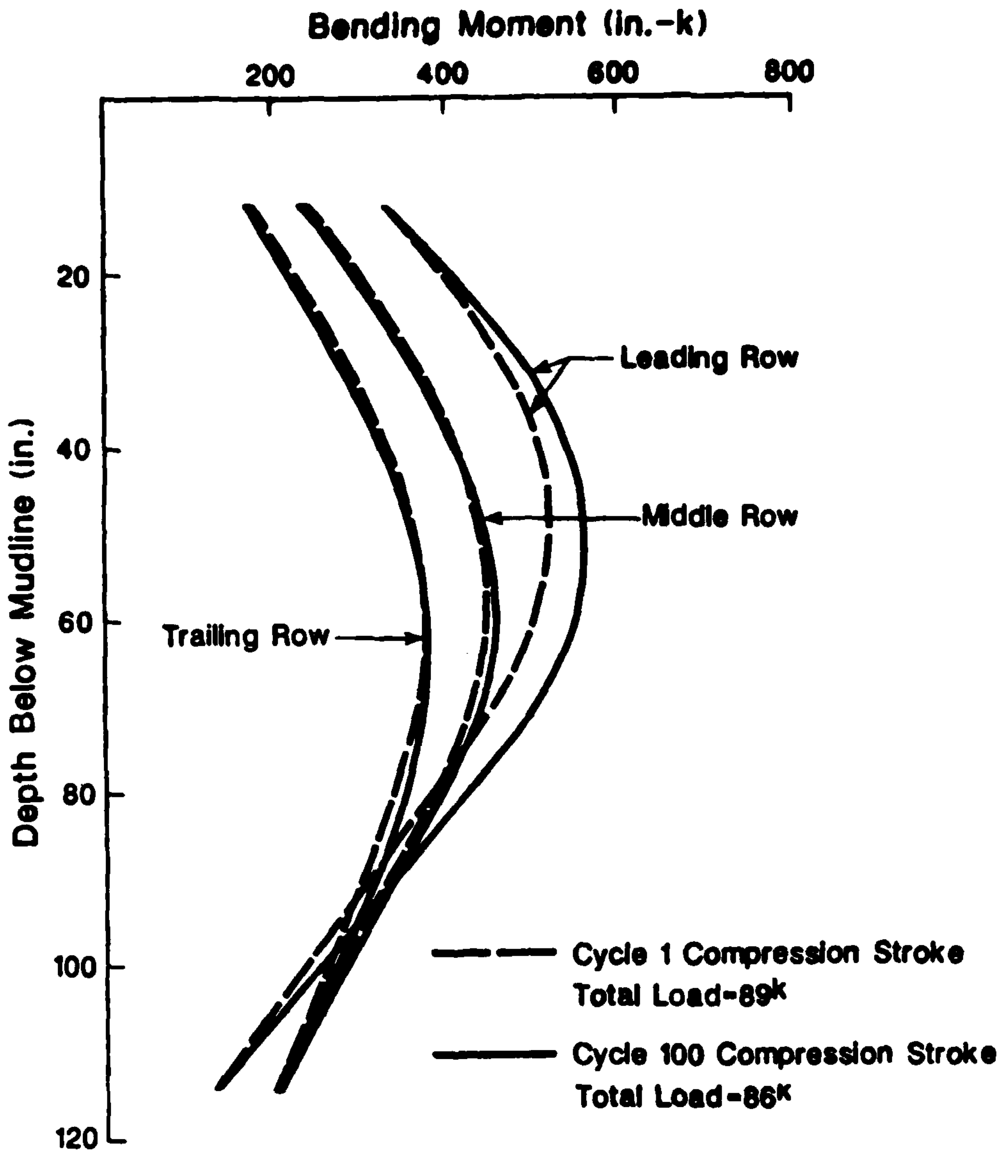


Fig. 5.30. Bending moment curves for load 3, compression stroke, pile-group test

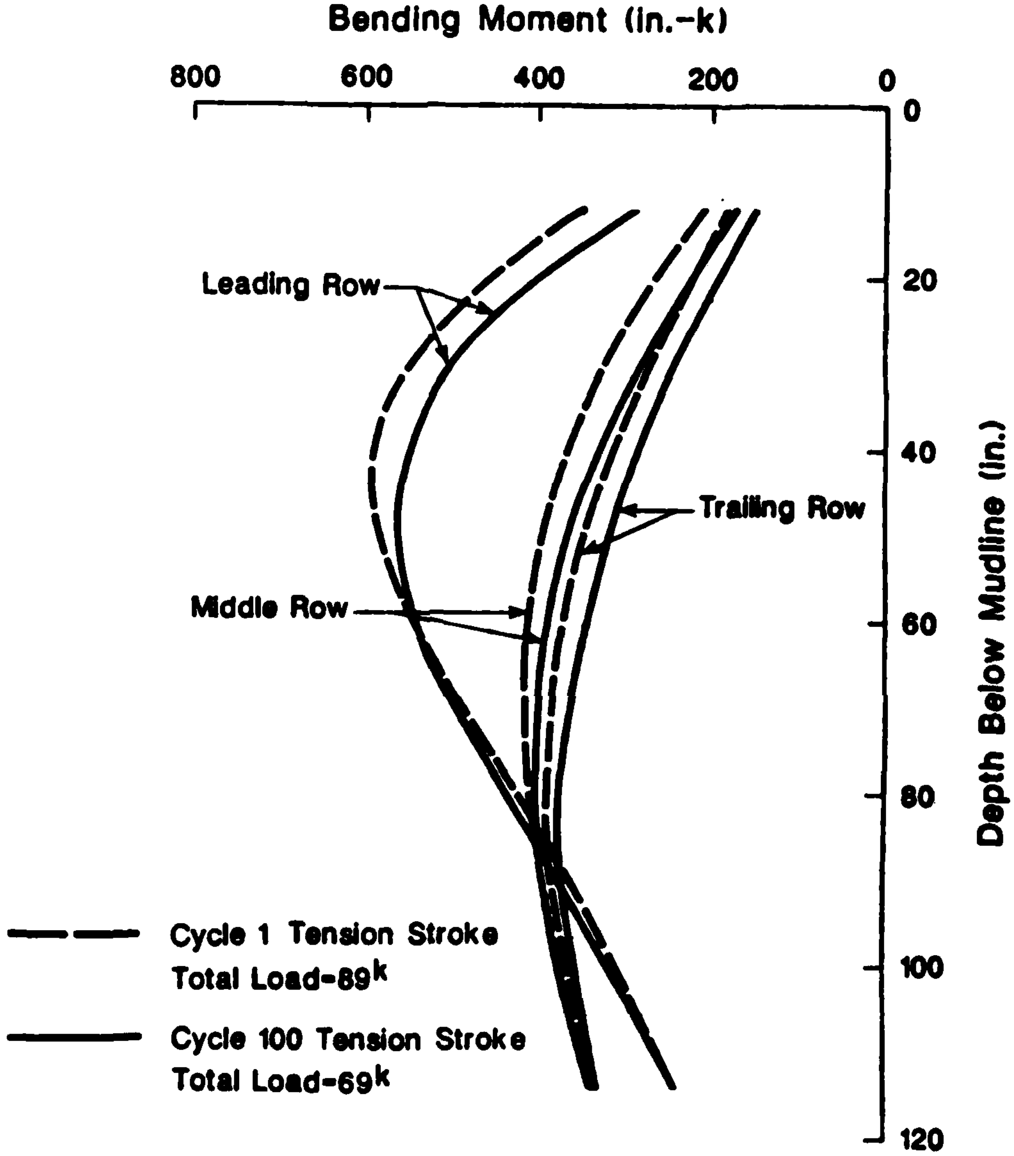


Fig. 5.31. Bending moment curves for load 3, tension stroke, pile-group test

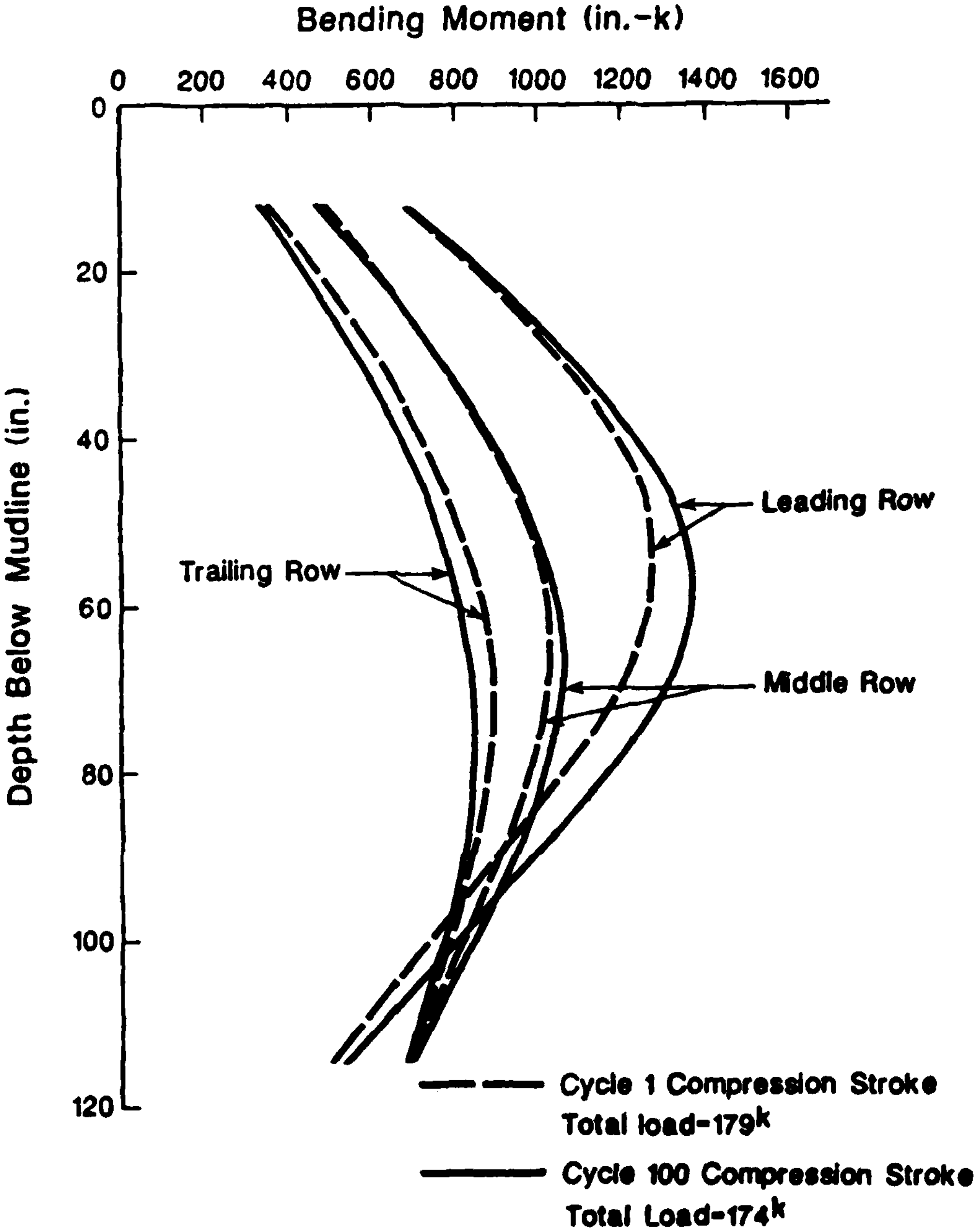


Fig. 5.32. Bending moment curves for load 5, compression stroke, pile-group test

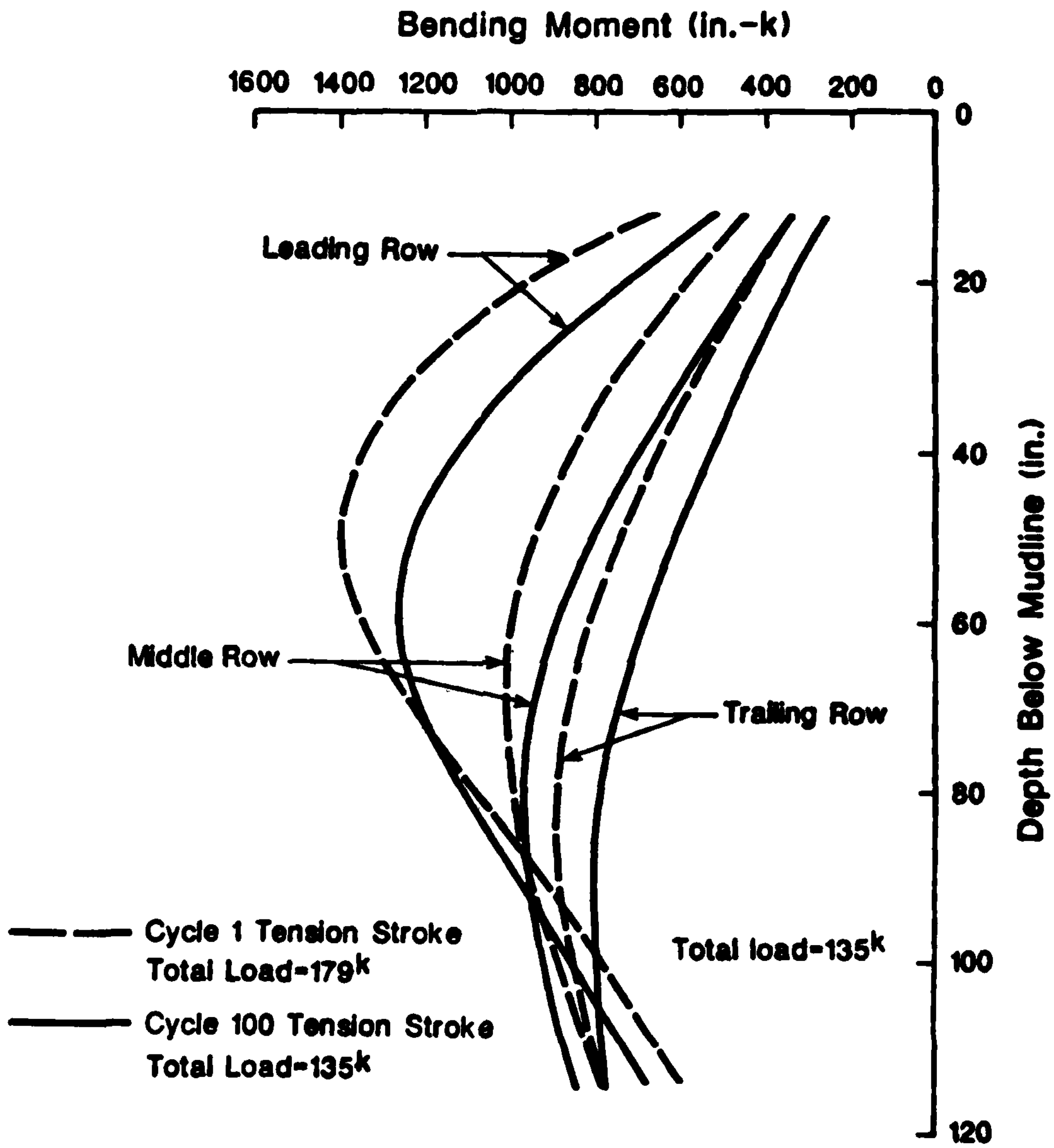


Fig. 5.33. Bending moment curves for load 5, tension stroke, pile-group test

and smallest for the trailing row. For the compression stroke, moments are larger for cycle 100 than for cycle 1. This increase in moment with repeated application of the load implies that soil resistance is decreasing. For the tension stroke, moments are smaller for cycle 100 than for cycle 1. This is due to the fact that the load for the tension stroke of cycle 100 is smaller than the load for the tension stroke of cycle 1.

**Load versus Maximum Moment**

The relationship between pile-head load and maximum bending moment for the pile group is shown in Fig. 5.34 for cycle 1 and Fig. 5.35 for cycle 100. It can be seen that for a given average of pile-head load, the maximum moment in the pile group is larger than the maximum moment in the isolated pile. It can also be seen that for any pile-head load, the maximum moment for cycle 100 is larger than for cycle 1. The difference between the behavior of the pile group on the compression stroke and that on the tension stroke is again apparent, and again the difference is larger for cycle 100 than for cycle 1.

**Soil Response**

The measured p-y curves for the compression stroke of cycle 1 for depths of 12, 24, 36, 48, 60, and 72 inches are shown in Figs. 5.36 to 5.41. The measured p-y

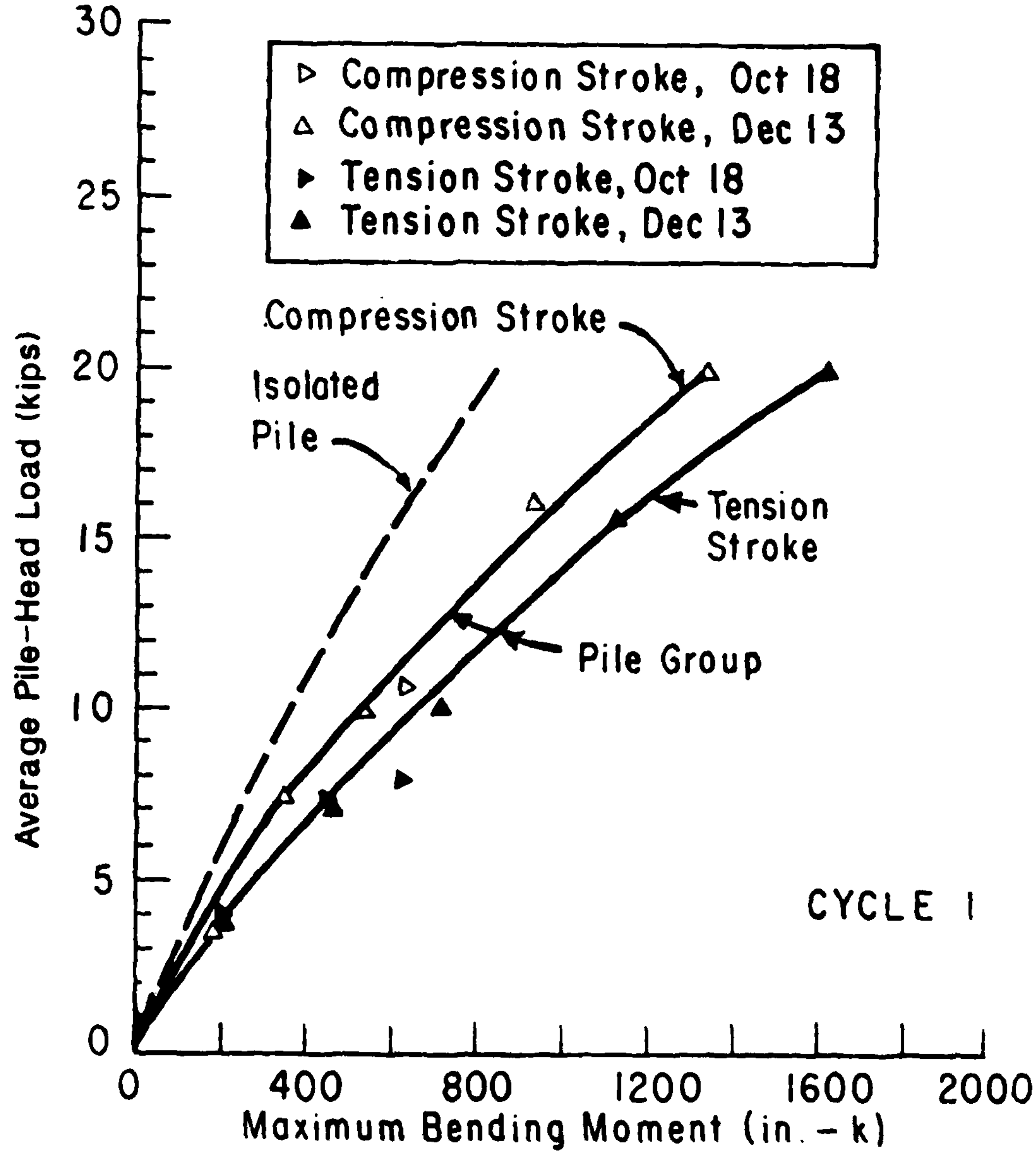


Fig. 5.34. Load-maximum moment curves for cycle 1, pile-group test.

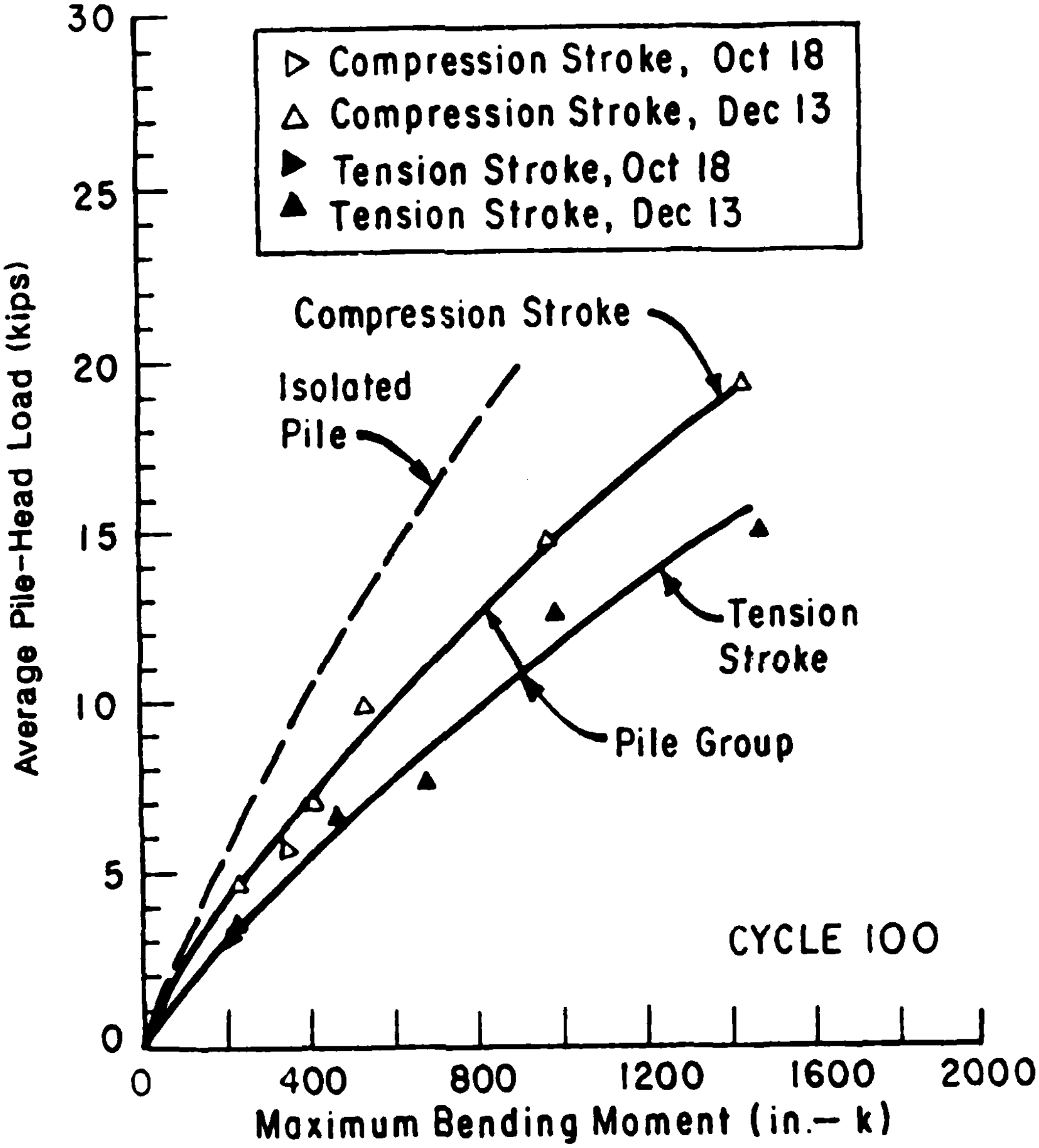


Fig. 5.35. Load-maximum moment curves for cycle 100, pile-group test.

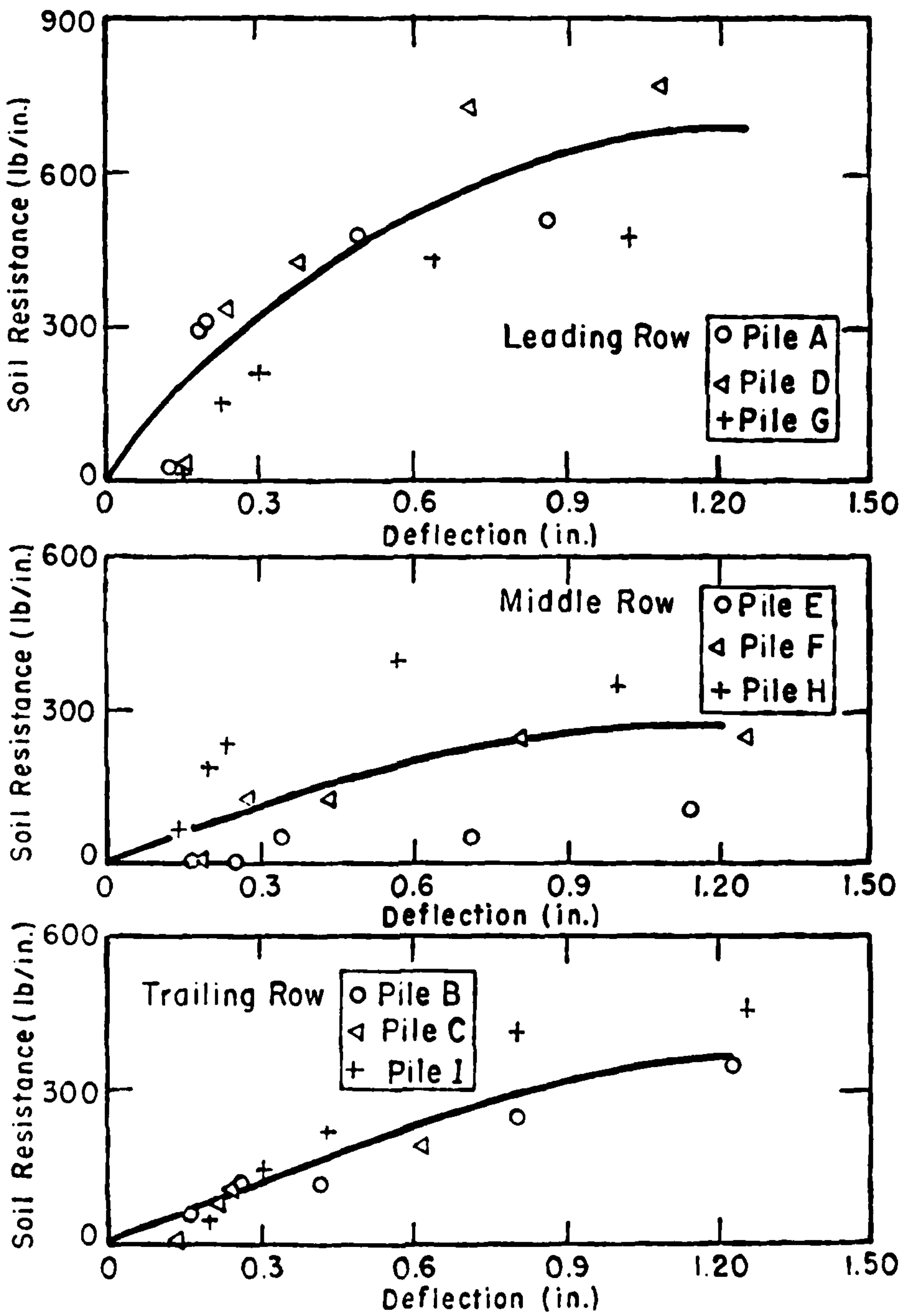


Fig. 5.36. Experimental p-y curves, cycle 1c, depth = 12 in., pile-group test.

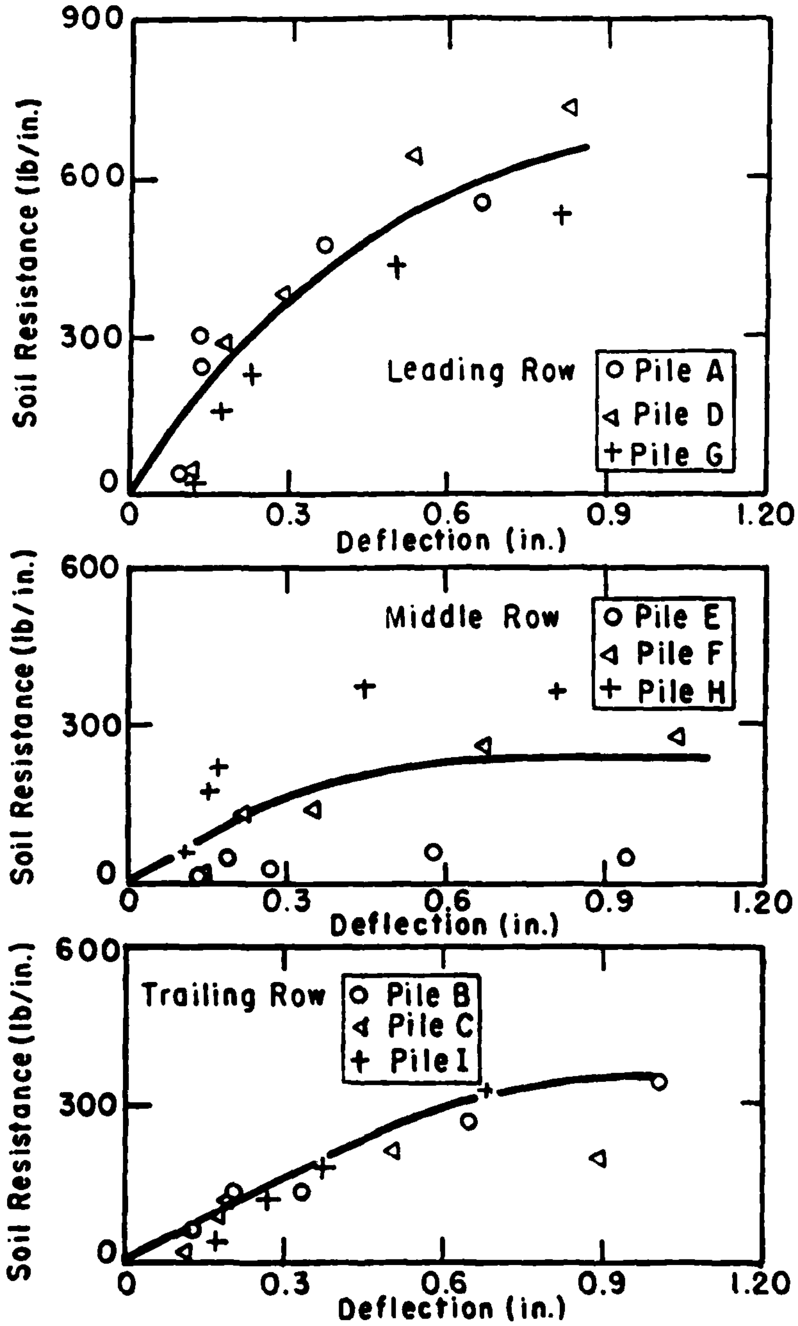


Fig. 5.37. Experimental p-y curves, cycle 1c, depth = 24 in., pile-group test.

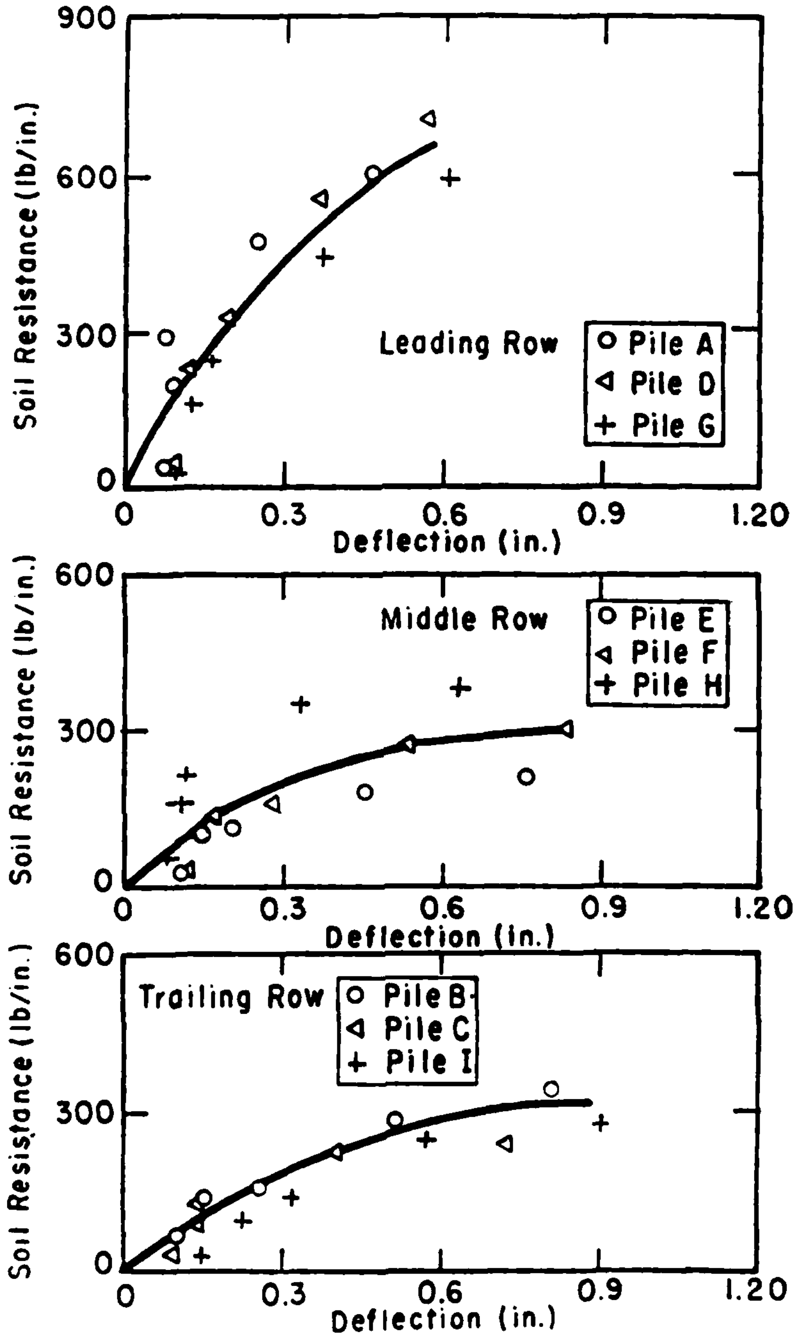


Fig. 5.38. Experimental p-y curves, cycle 1c, depth = 36 in., pile-group test.

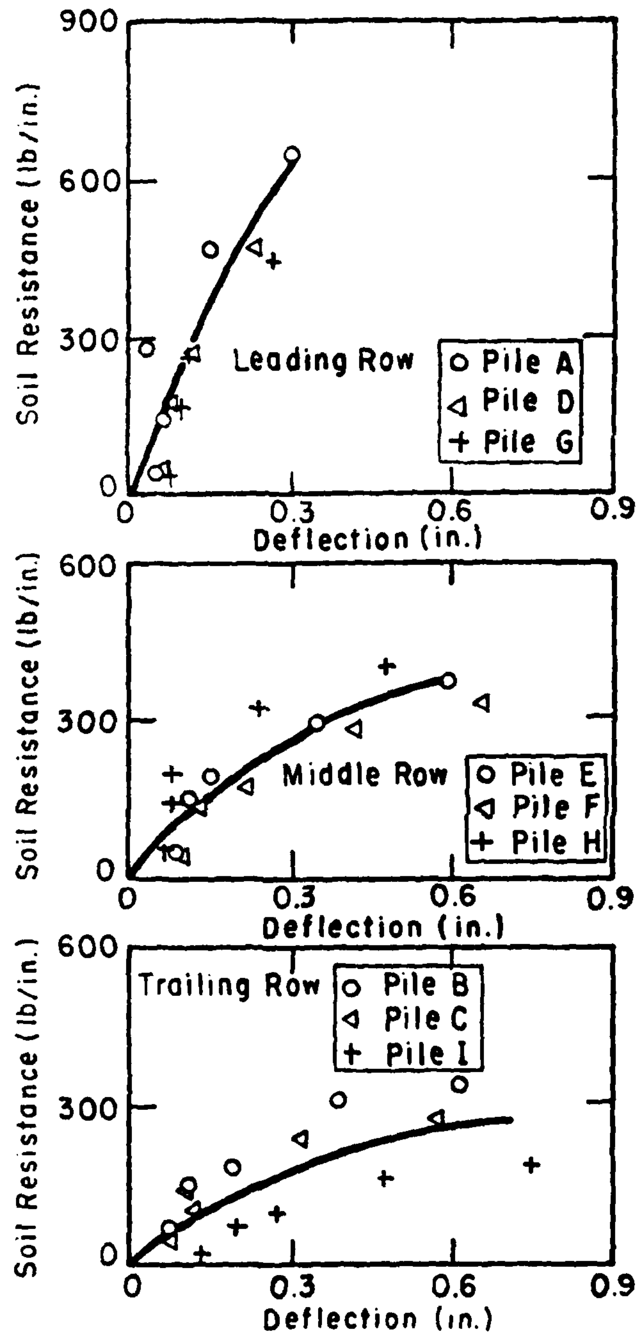


Fig. 5.39. Experimental p-y curves, cycle 1c, depth = 48 in., pile-group test.

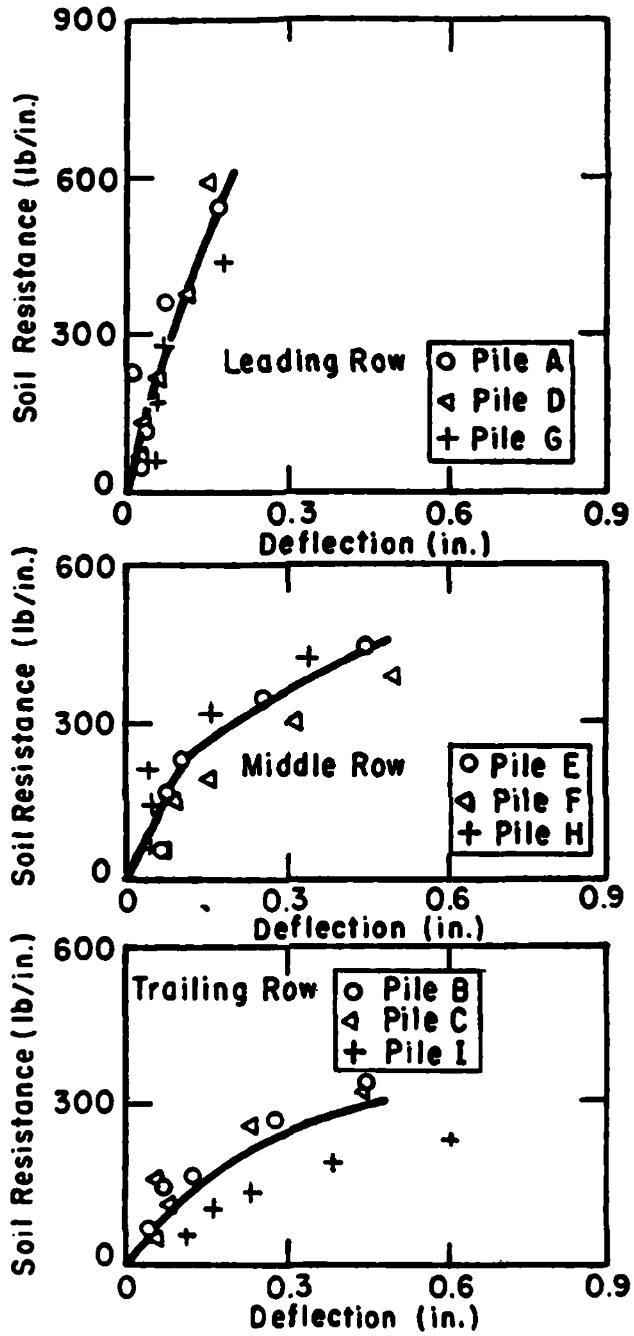


Fig. 5.40. Experimental p-y curves, cycle 1c, depth = 60 in., pile-group test.

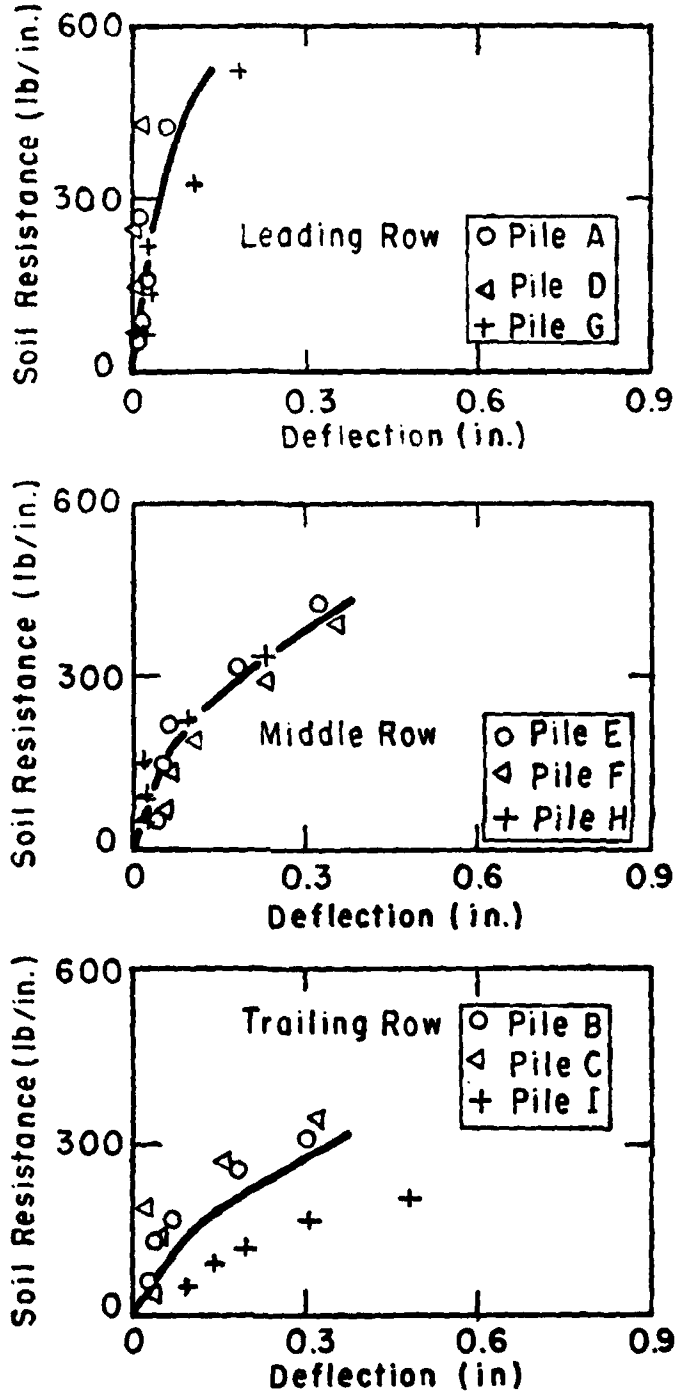


Fig. 5.41. Experimental p-y curves, cycle 1c, depth = 72 in., pile-group test.

curves for the compression stroke of cycle 1 are shown in Figs. 5.42 to 5.47. The measured p-y curves for the compression stroke of cycle 100 are shown in Figs. 5.48 to 5.53. The measured p-y curves for the tension stroke of cycle 100 are shown in Figs. 5.54 to 5.59. Separate curves are presented for each row of piles.

An examination of Figs. 5.36 through 5.59 reveals that the soil resistance for the leading row of piles is greater than the resistance for the middle and trailing rows. For the upper portion of the instrumented sections of the piles, the soil resistance for the middle and trailing rows is similar. For the lower portion, the soil resistance for the middle row is greater than the resistance for the trailing row. Comparing a soil response curve for the static case with the corresponding curve for the cyclic case shows that the resistance curve for the static case is greater than for the cyclic case.

## CONCLUDING COMMENTS

The results of load tests for a single pile and a group of piles have been summarized in this chapter. Based on the results presented, the following conclusions can be drawn.

1. The response of the single pile to lateral load is stiffer than the response of the average pile in the pile group.

2. For both the single pile and the pile group, the response of the piles to static loading is stiffer than the response to cyclic loading.

3. The distribution of load to the piles in the group is not uniform. The leading row takes a larger portion of the load than the middle row, which in turn takes a larger portion than the trailing row.

4. The ultimate soil resistance for the leading row of piles is larger than the ultimate soil resistance for the middle row which is in turn larger than that for the trailing row.

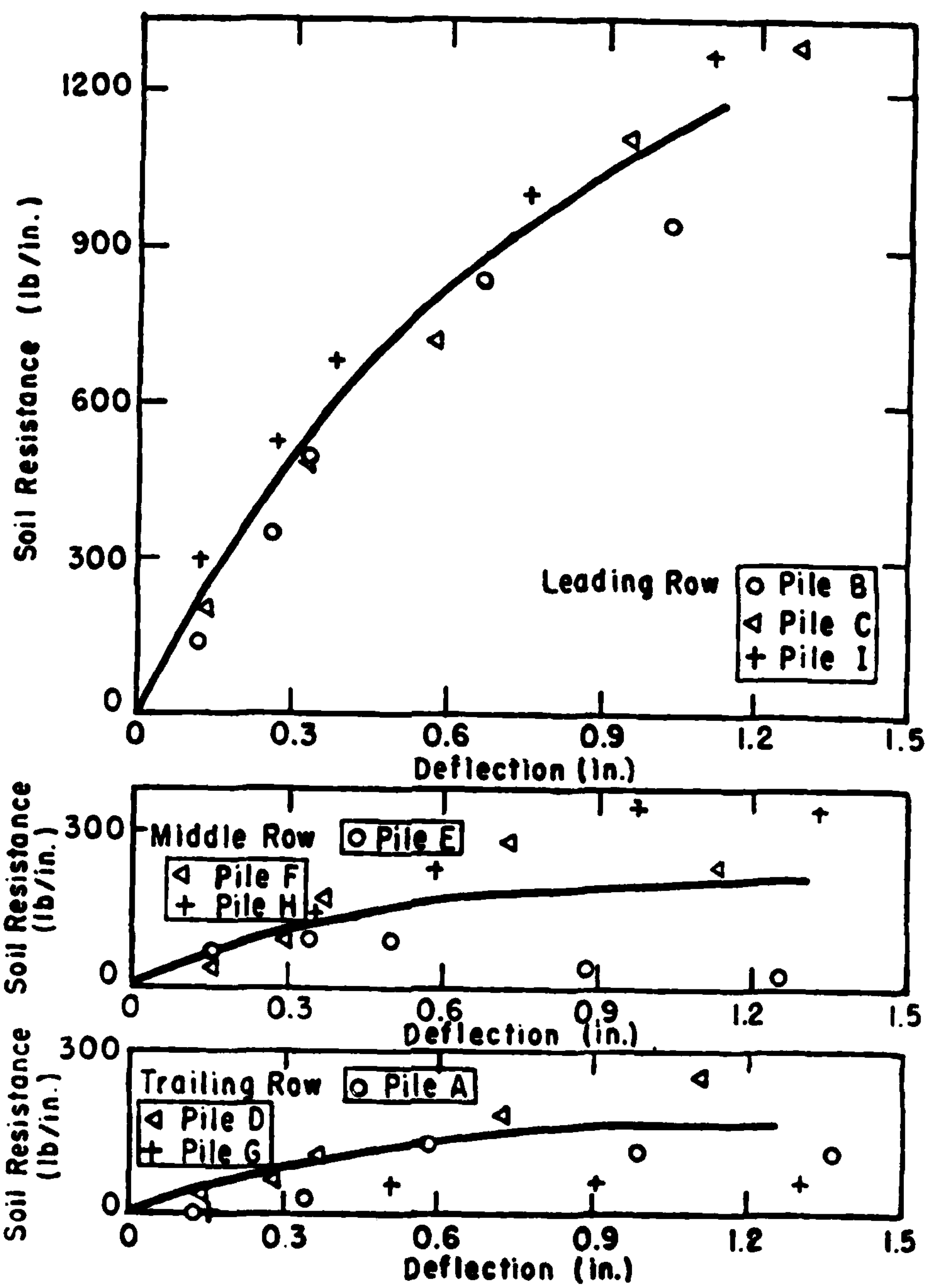


Fig. 5.42. Experimental p-y curves, cycle 1T, depth = 12 in., pile-group test.

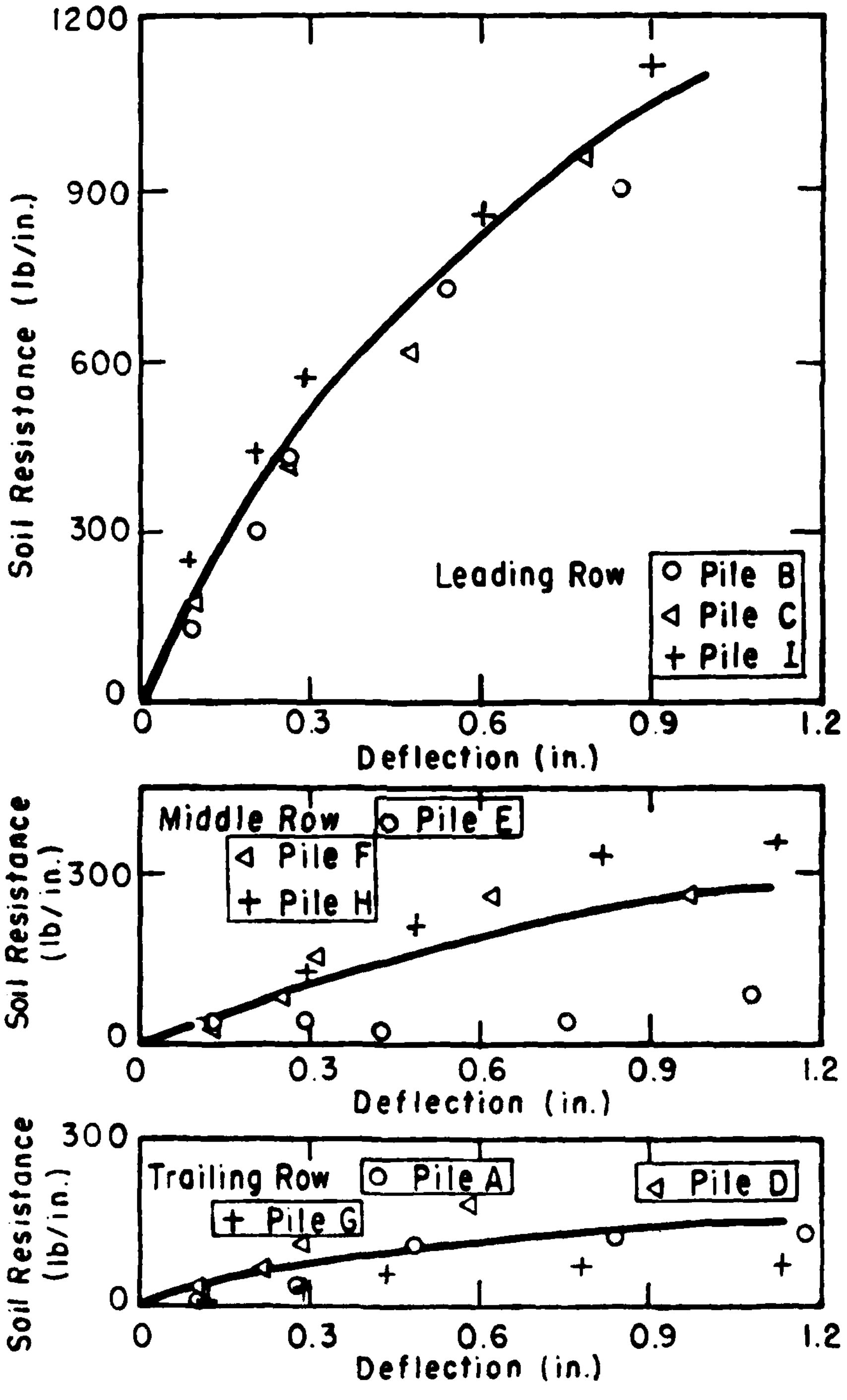


Fig. 5.43. Experimental p-y curves, cycle 1T, depth = 24 in., pile-group test.

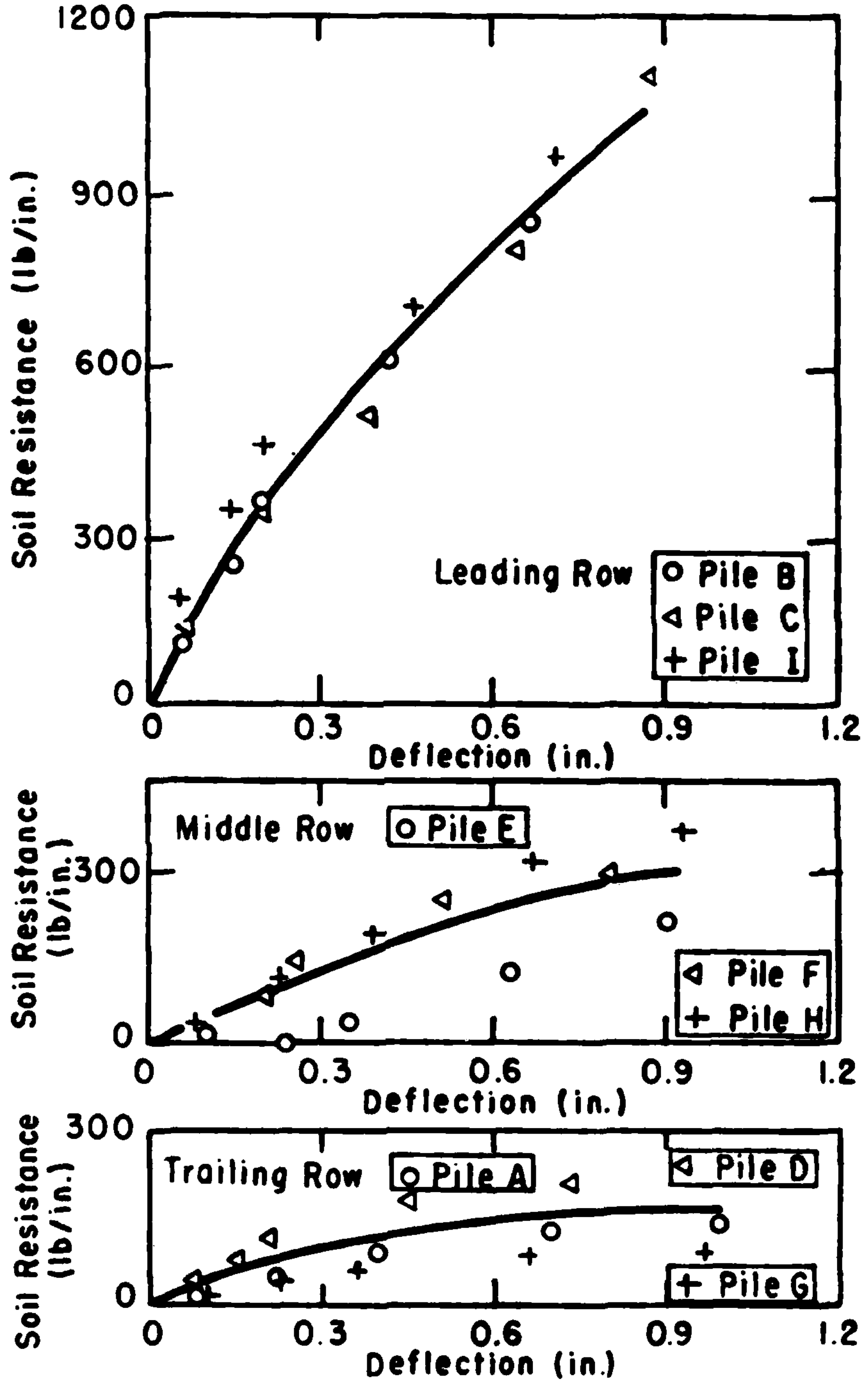


Fig. 5.44. Experimental p-y curves, cycle 1T, depth = 36 in., pile-group test.

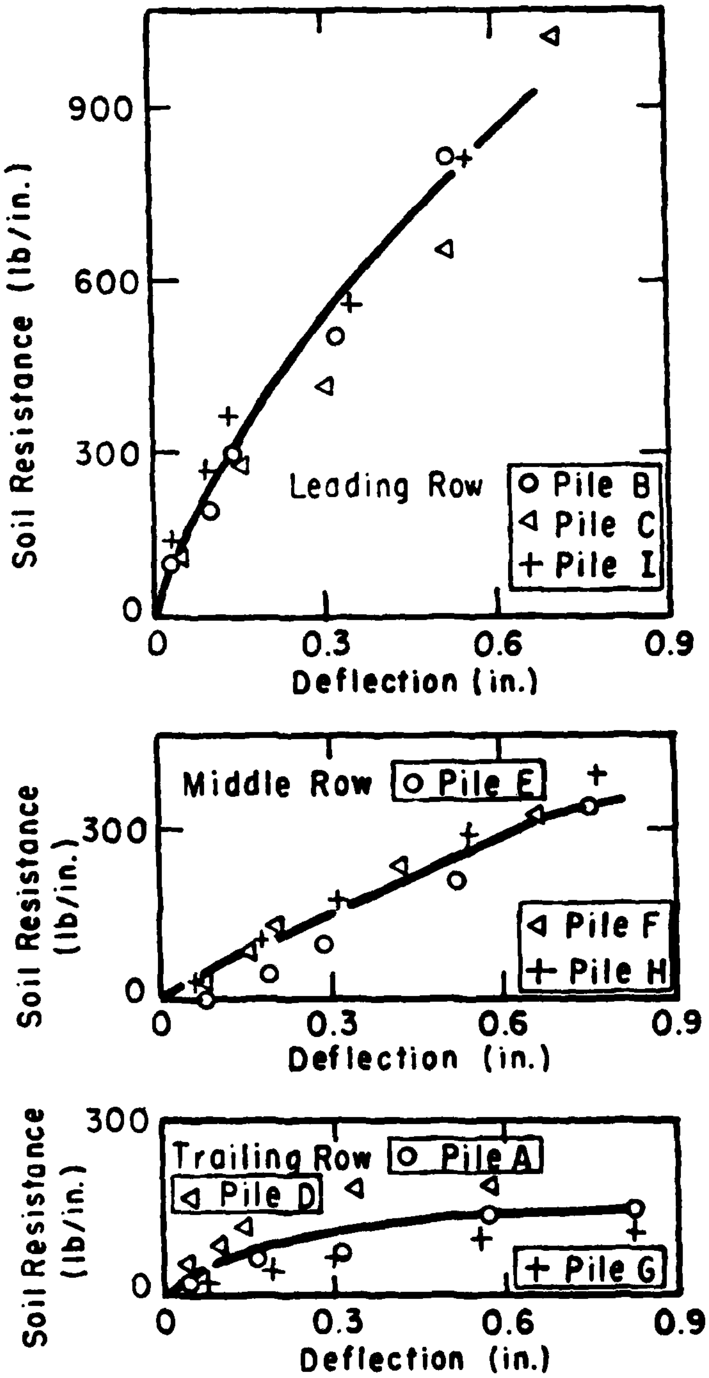


Fig. 5.45. Experimental p-y curves, cycle 1T, depth = 48 in., pile-group test.

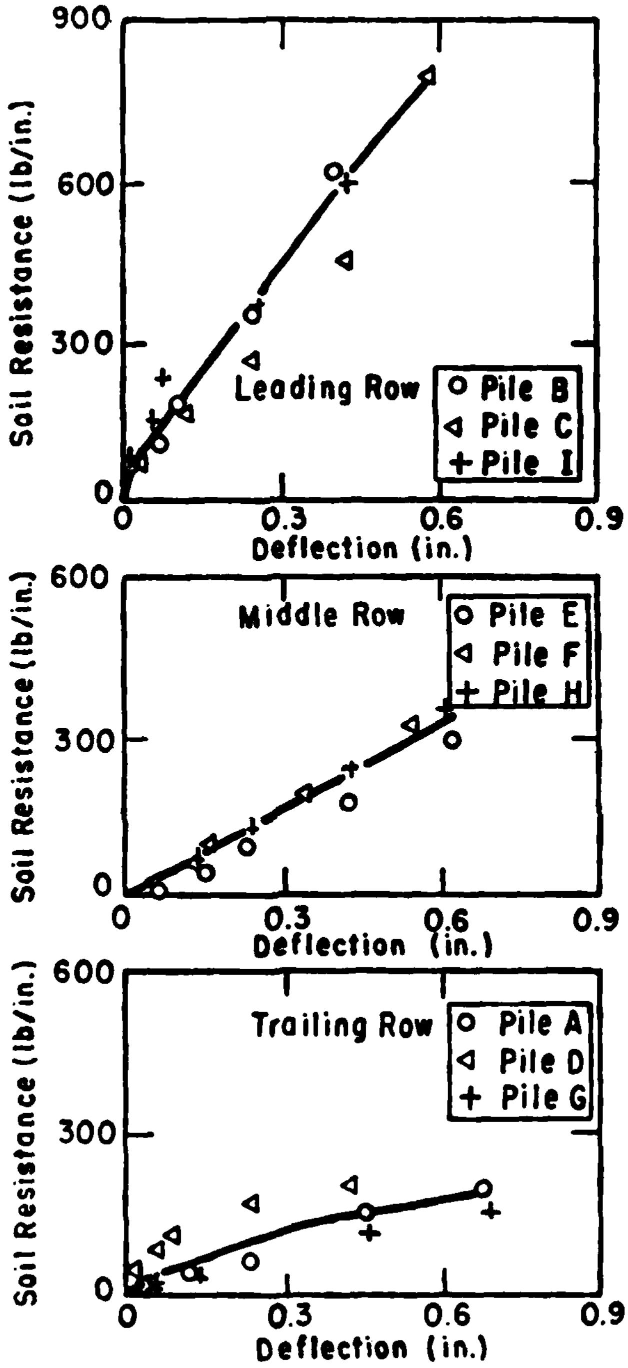


Fig. 5.46. Experimental p-y curves, cycle 1T, depth = 60 in., pile-group test.

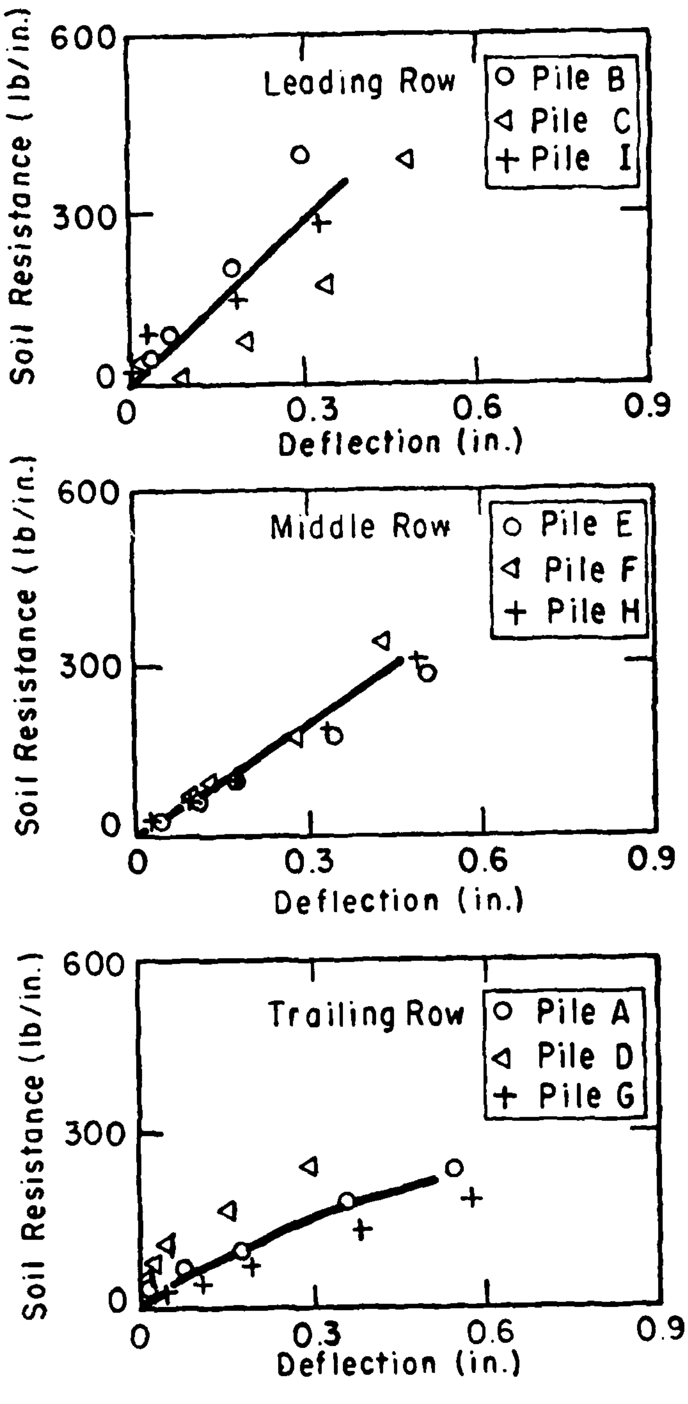


Fig. 5.47. Experimental p-y curves, cycle 1T, depth = 72 in., pile-group test.

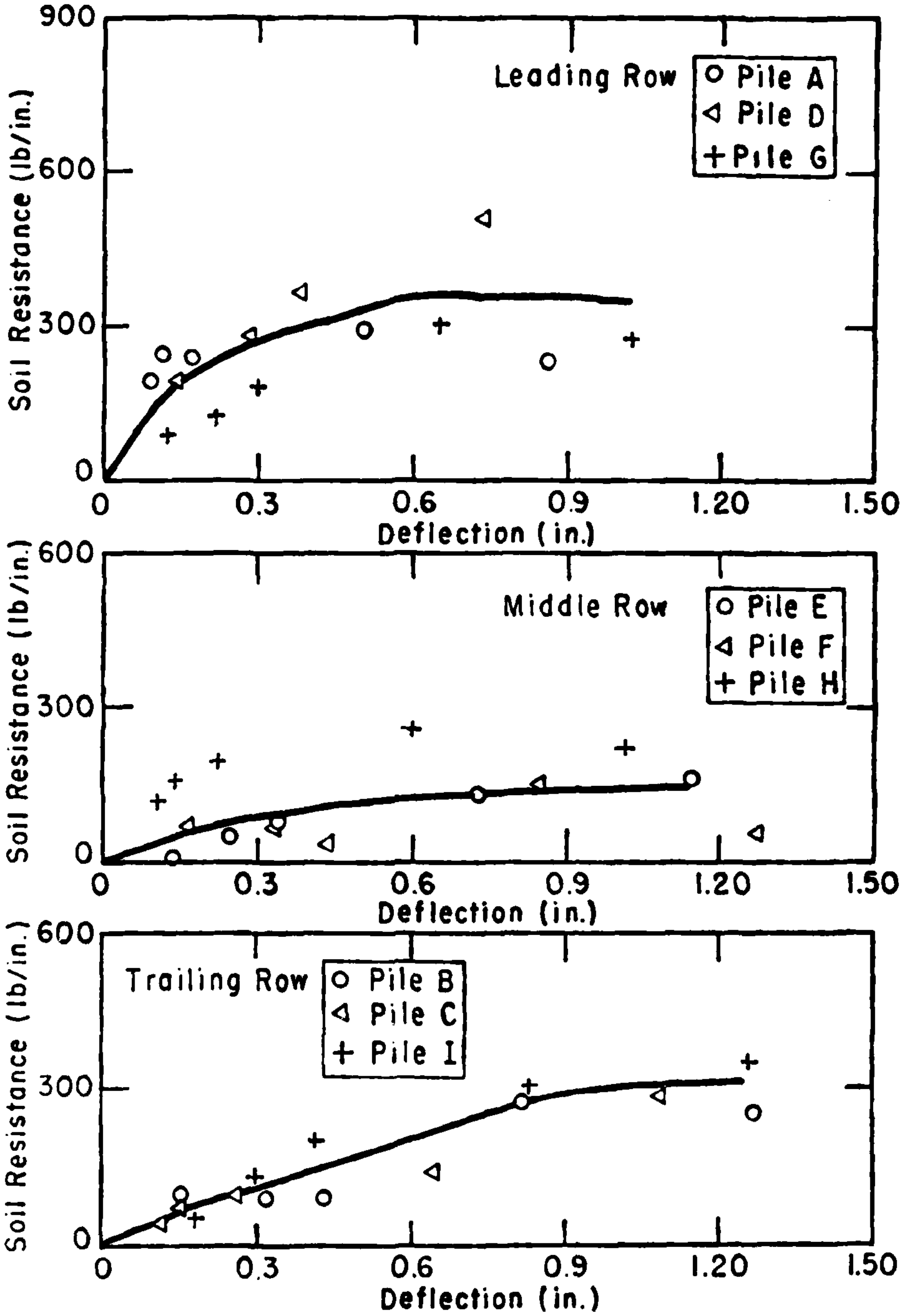


Fig. 5.48. Experimental p-y curves, cycle 100c, depth = 12 in., pile-group test.

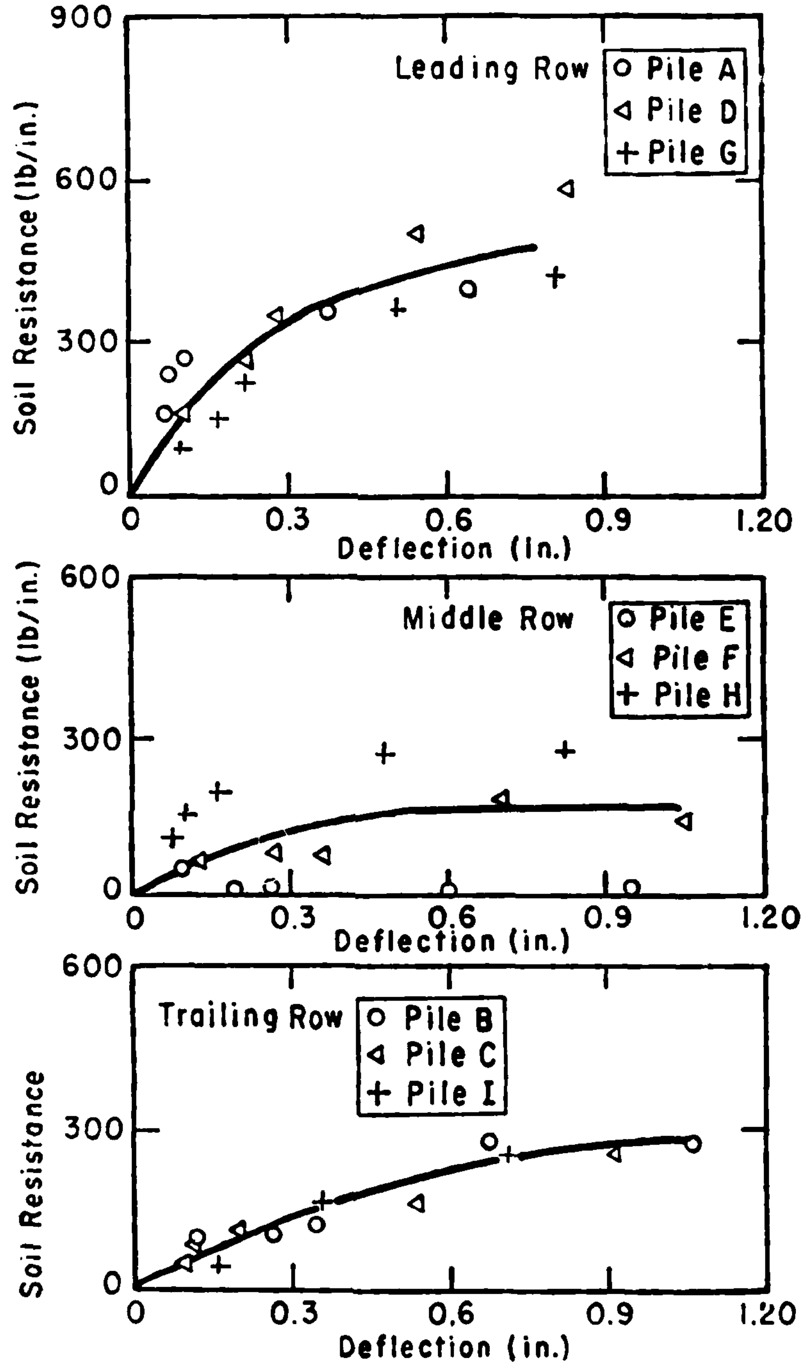


Fig. 5.49. Experimental p-y curves, cycl< 100c, depth = 24 in., pile-group test.

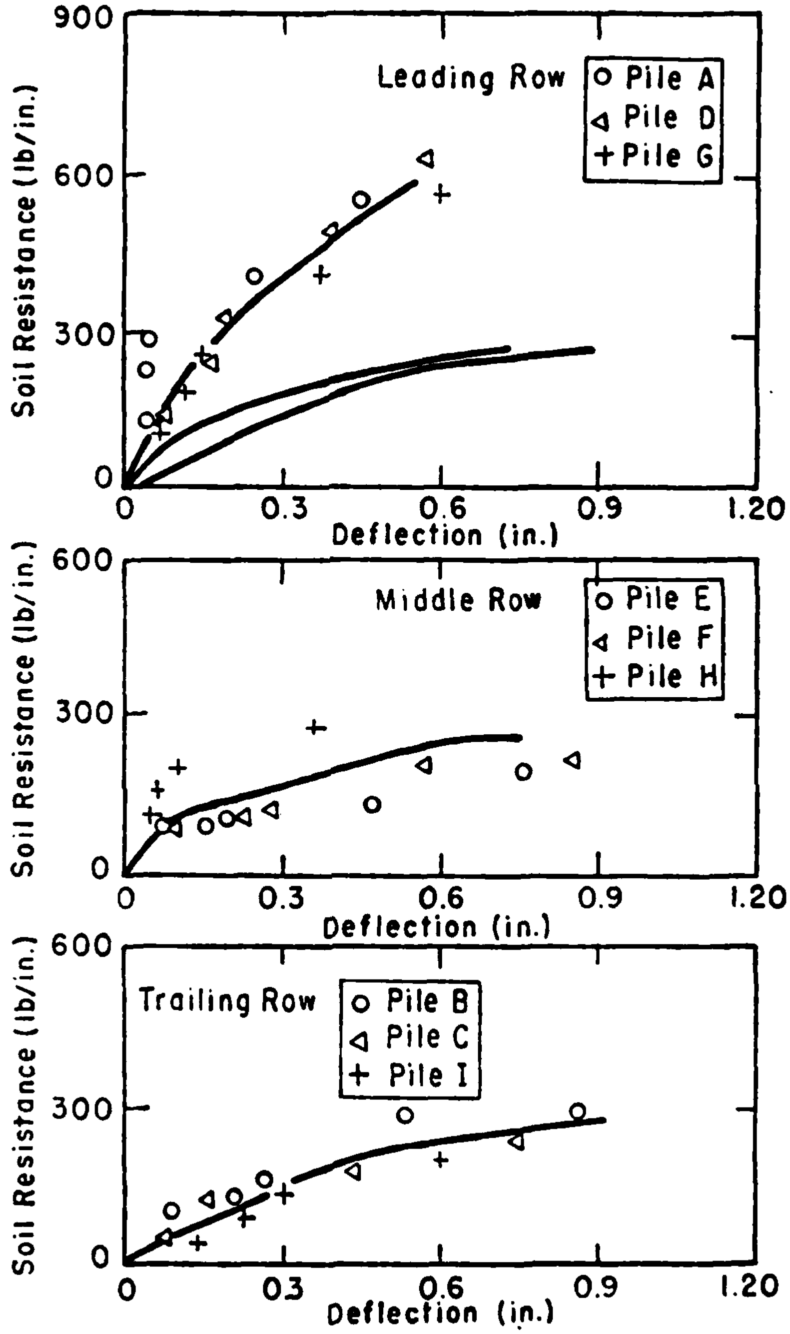


Fig. 5.50. Experimental p-y curves, cycle 100c, depth = 36 in., pile-group test.

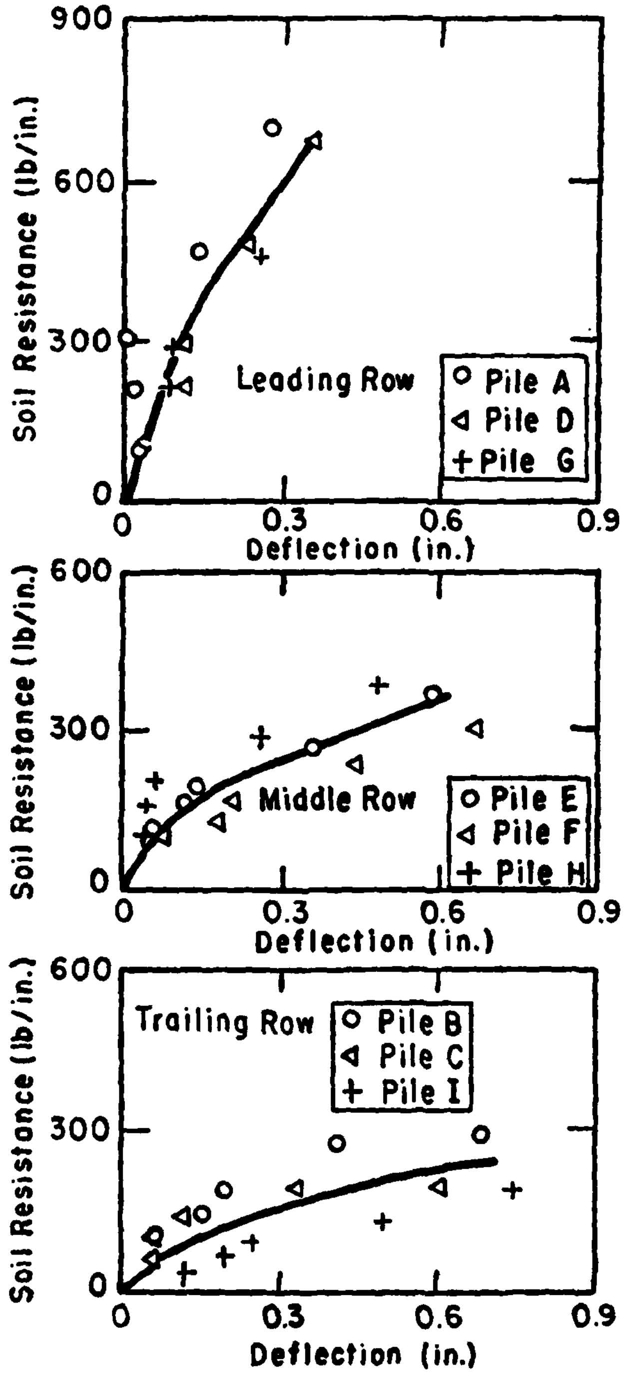


Fig. 5.51. Experimental p-y curves, cycle 100c, depth = 48 in., pile-group test.

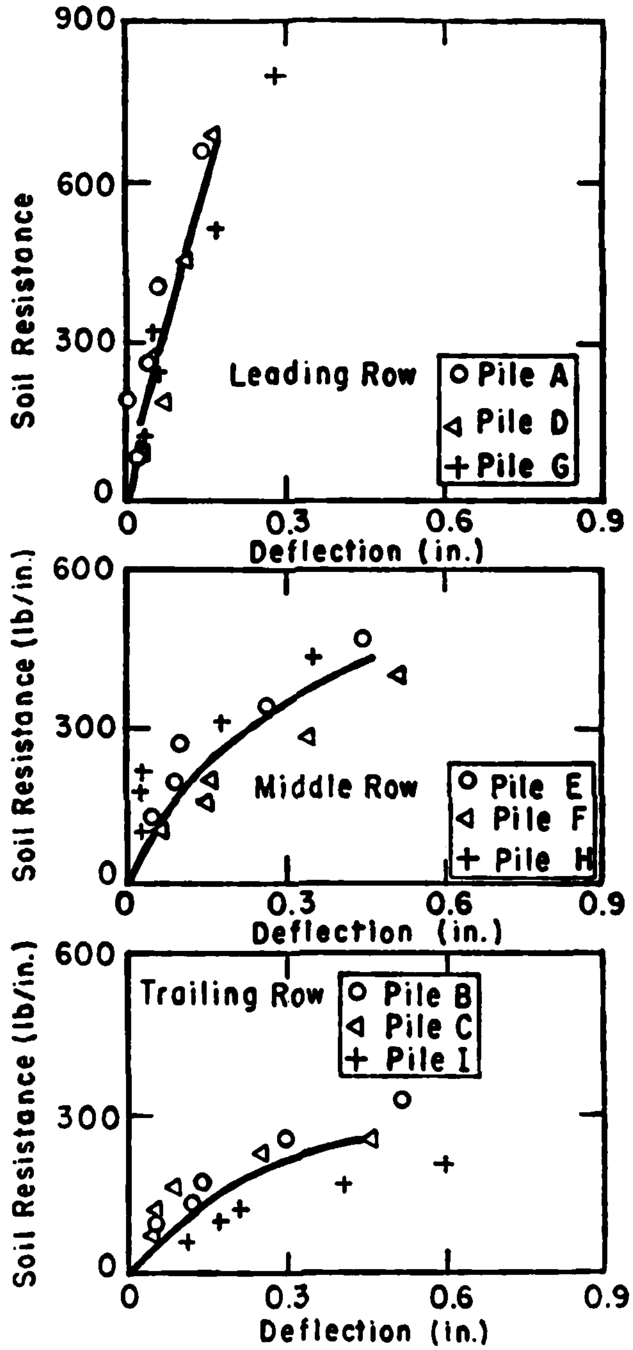


Fig. 5.52. Experimental p-y curves, cycle 100c, depth = 60 in., pile-group test.

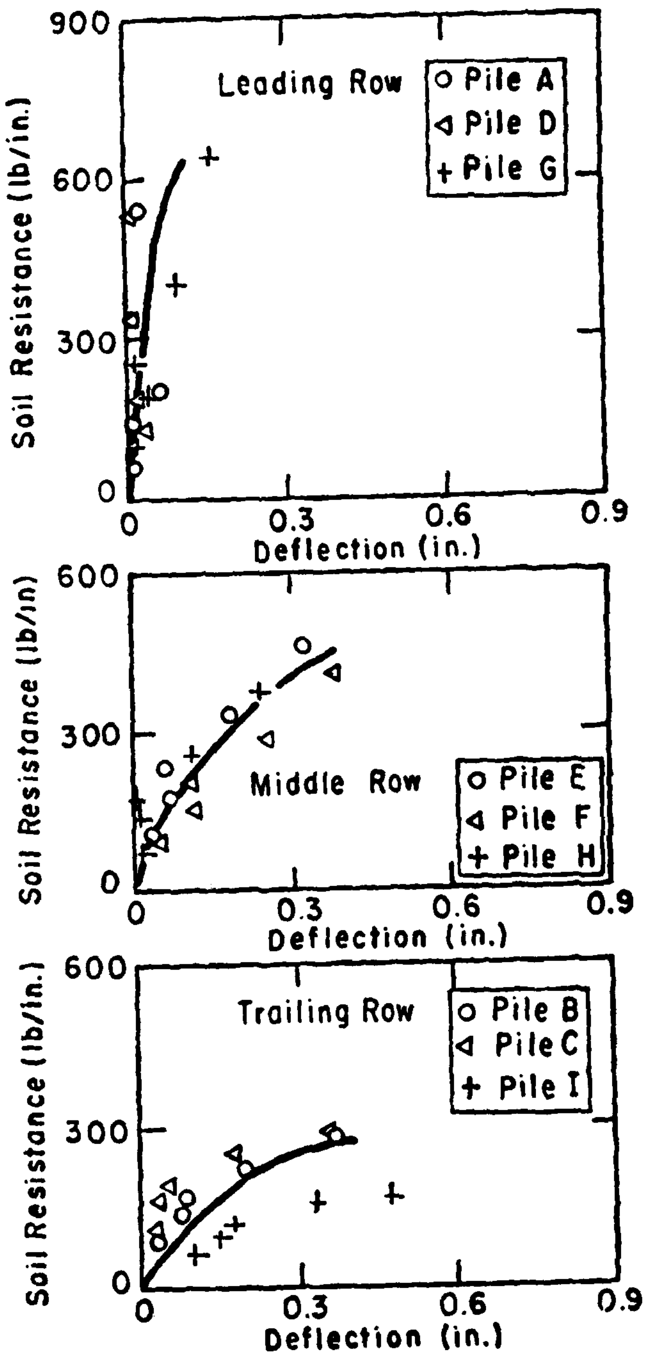


Fig. 5.53. Experimental p-y curves, cycle 100c, depth = 72 in., pile-group test.

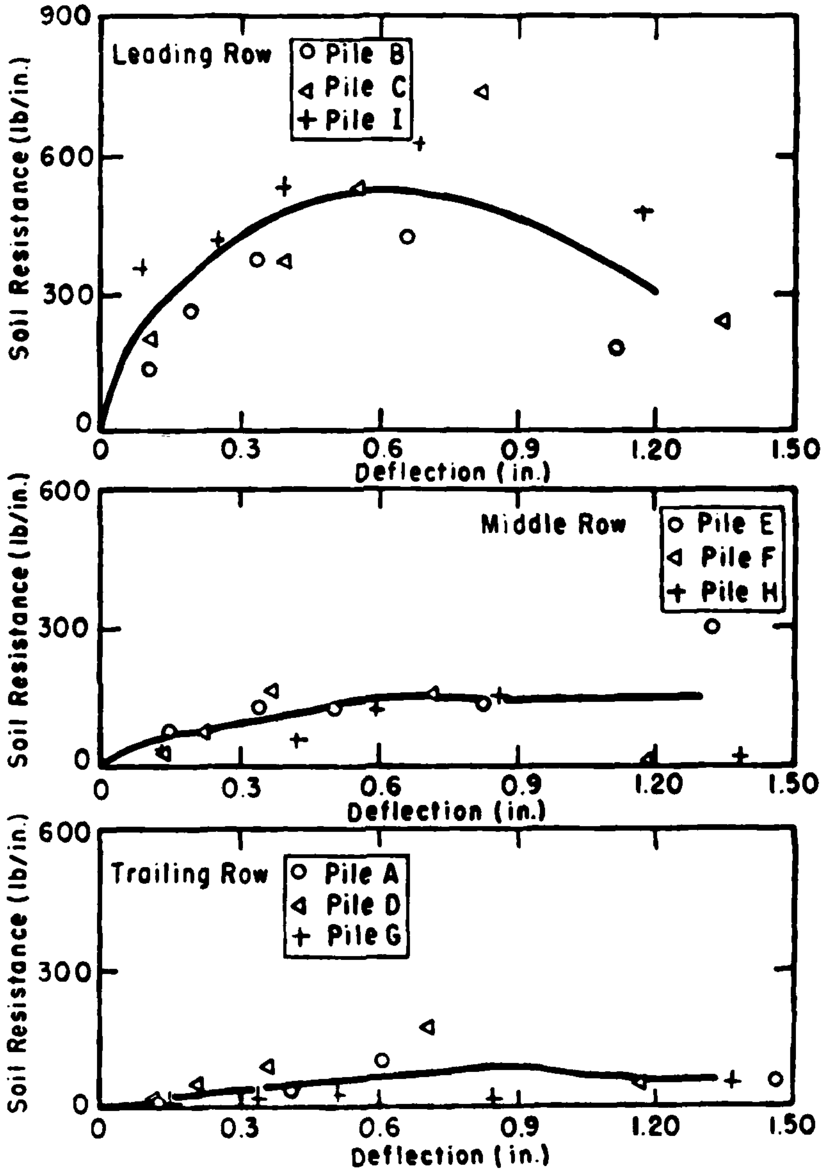


Fig. 5.54. Experimental p-y curves, cycle 100T, depth = 12 in., pile-group test.

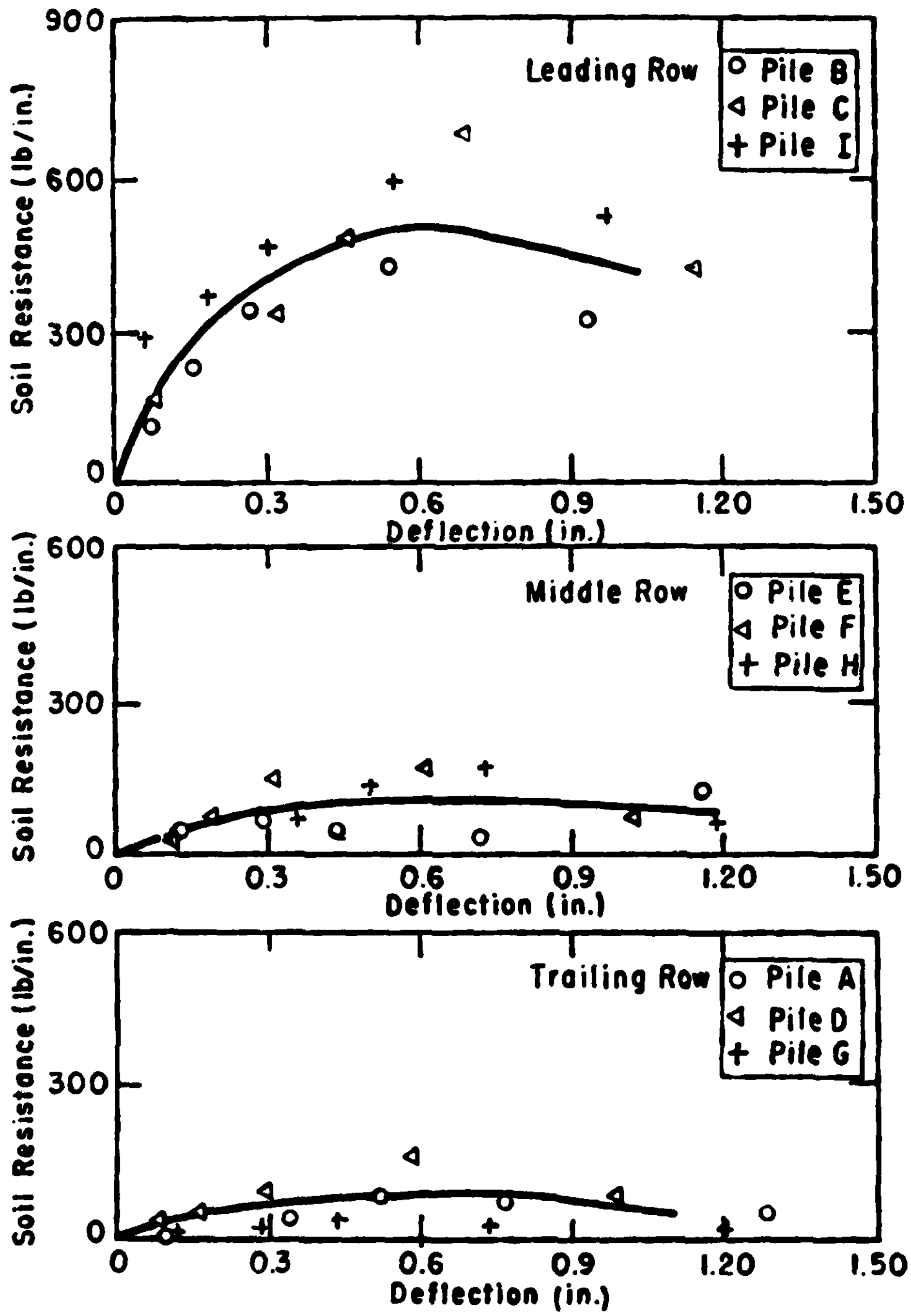


Fig. 5.55. Experimental p-y curves, cycle 100T, depth = 24 in., pile-group test.

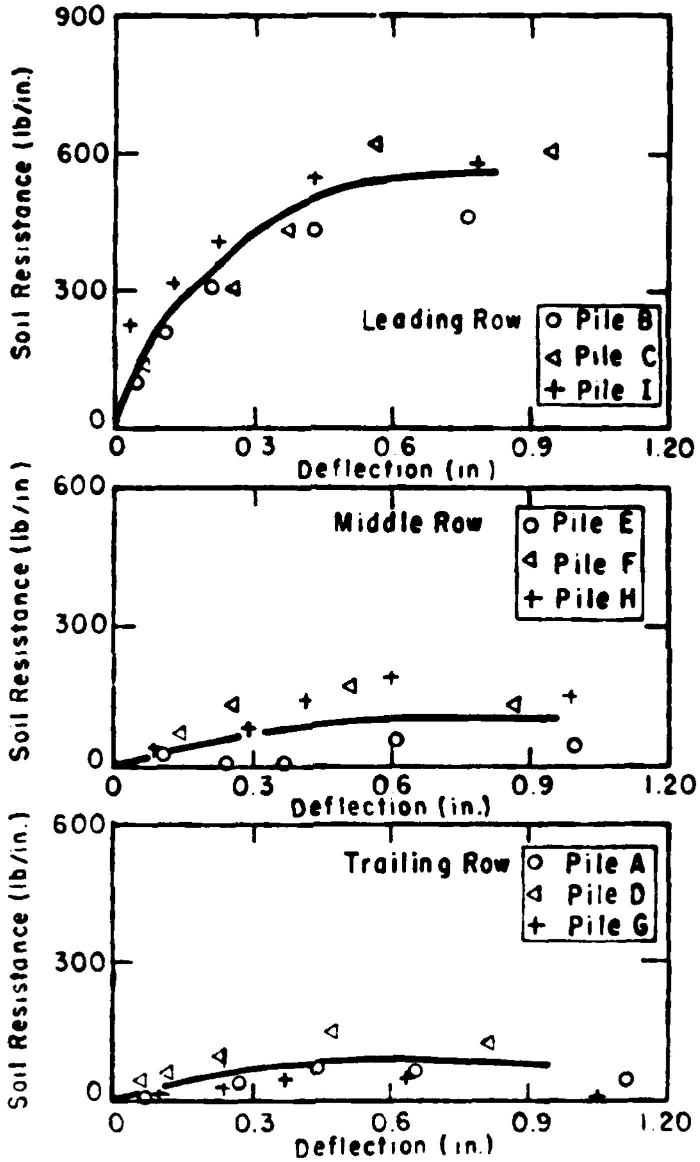


Fig. 5.56. Experimental p-y curves, cycle 100T, depth = 36 in., pile-group test.

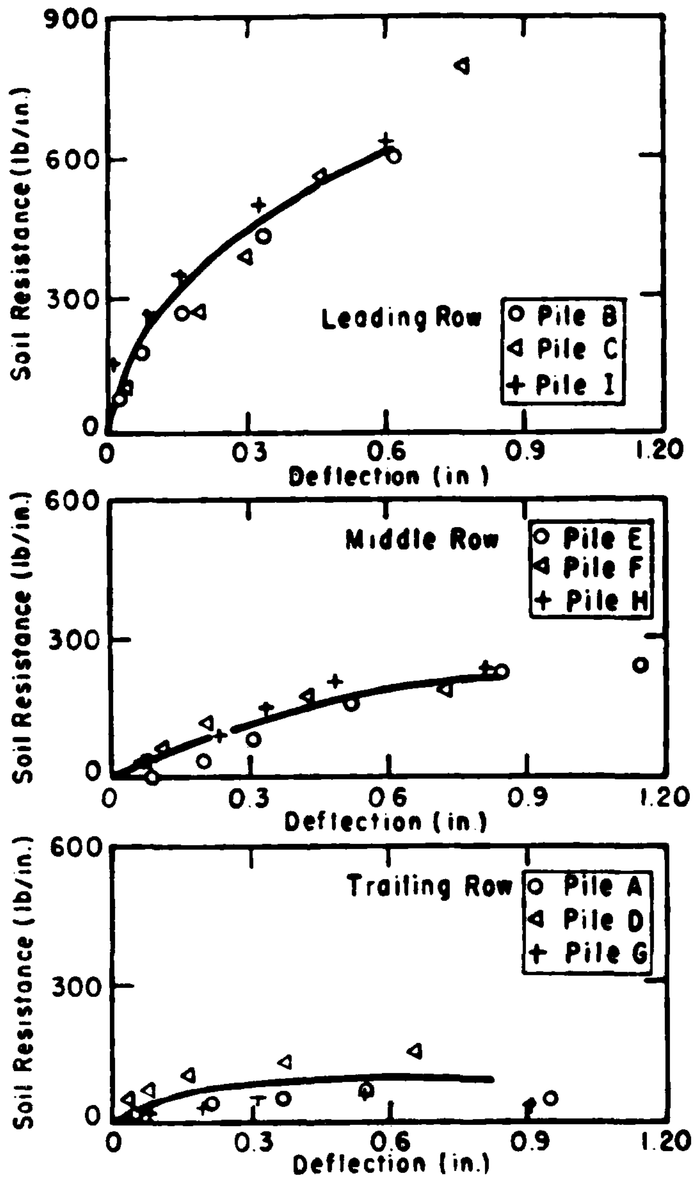


Fig. 5.57. Experimental p-y curves, cycle 100T, depth = 48 in., pile-group test.

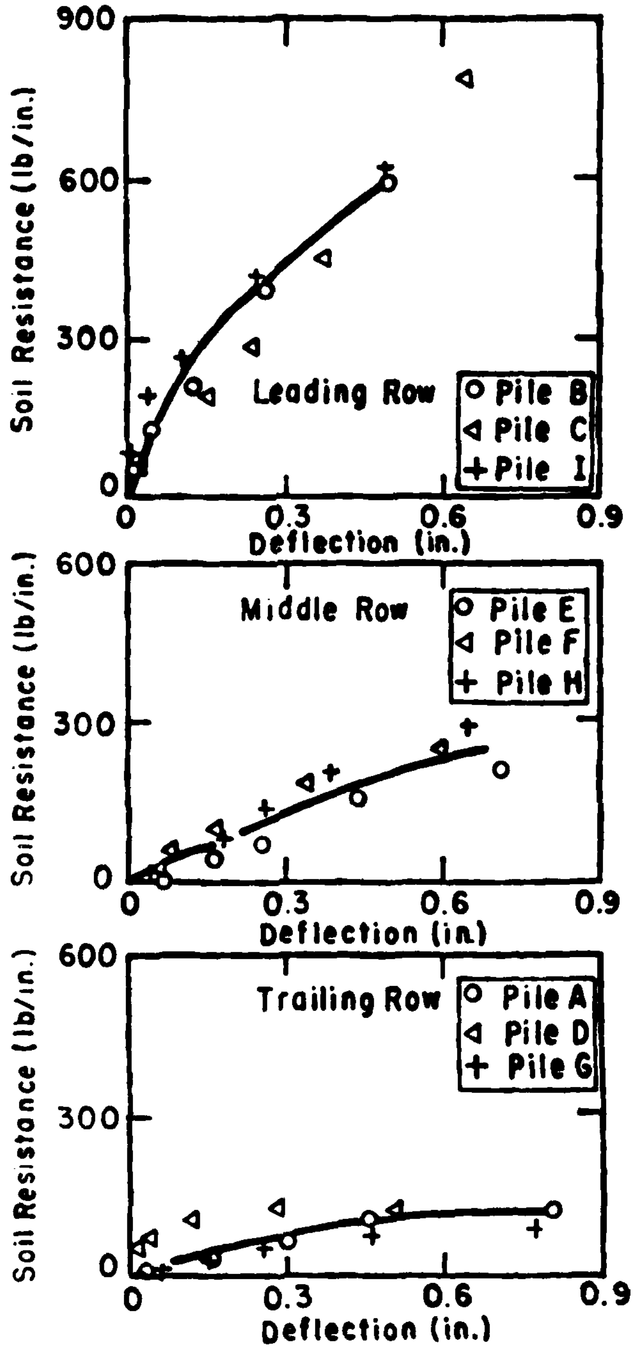


Fig. 5.58. Experimental p-y curves, cycle 100T, depth = 60 in., pile-group test.

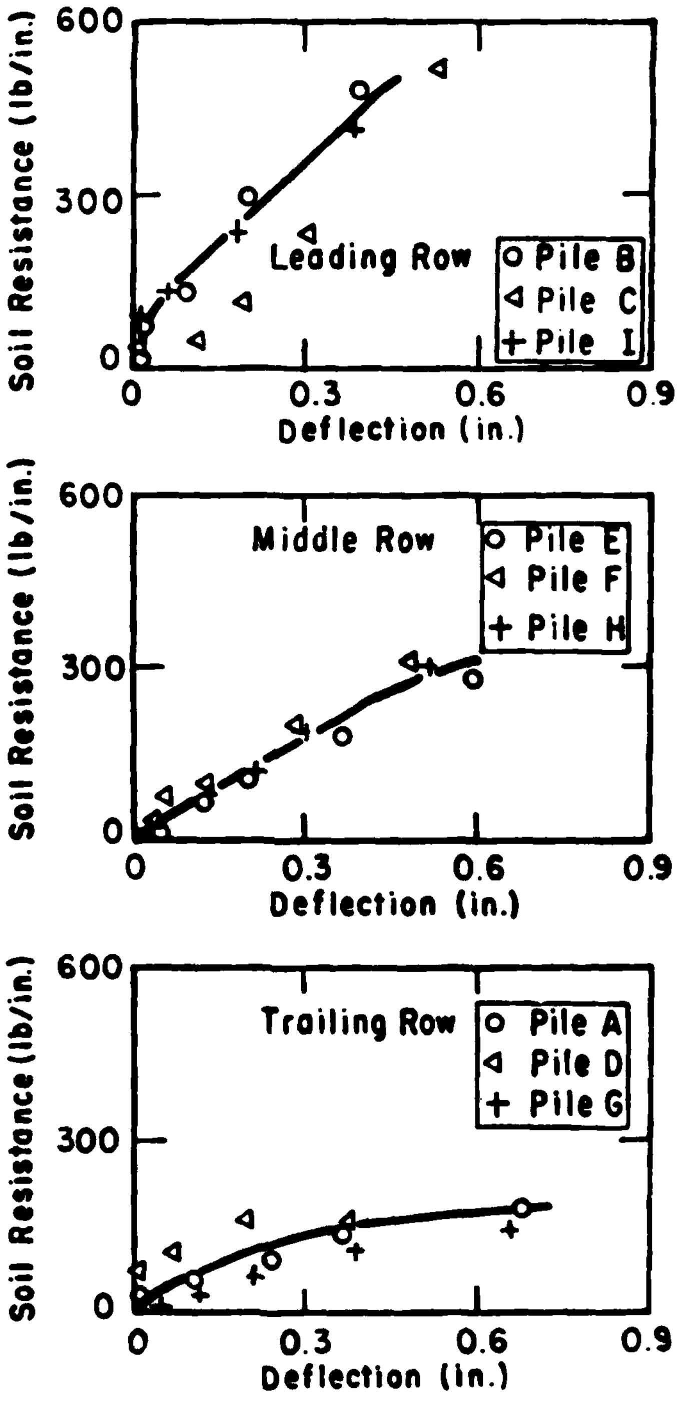


Fig. 5.59. Experimental p-y curves, cycle 100T, depth = 72 in., pile-group test.

## CHAPTER 6

## COMPARISON OF MEASURED BEHAVIOR OF THE GROUP OF PILES WITH THE BEHAVIOR PREDICTED BY CURRENT DESIGN METHODS

### INTRODUCTION

A number of analytical methods are currently available to the design professional to predict the behavior of a group of closely-spaced piles in sand. Presented in this chapter are comparisons of the measured behavior of the group of piles with the results of some of these methods. In all cases an attempt was made to calculate group behavior based on the measured behavior of the single pile. The methods examined in this chapter include DEFPIG, the Focht-Koch method, the single-pile method, and the Bogard-Matlock method. These methods have been described in detail by Brown and Reese (1985). A brief description of each method is included in this chapter.

While the comparisons presented in this chapter may be useful in evaluating the validity of the various analytical procedures, several differences between the conditions of the load test and those that might be expected in the field should be kept in mind. First, though the scale of the tested group is much larger than possible in a laboratory, actual pile groups, particularly

those used offshore, may include much larger piles. Second, for this load test, sand was placed around the piles. Driving the piles into the sand is a more common construction procedure and results in a change in density of the sand in the neighborhood of the piles. Third, as noted in Chapter 4, the peak deflection was held constant in this experiment as the load was cycled. In most cases a group of piles would be designed for cycling at a constant peak load. Despite these differences, the comparisons presented in this chapter should provide some insight into the usefulness of the analytical methods considered.

**DEFPIG**

DEFPIG is a computer program that uses a method based on the solutions presented by Poulos (1971a & b) to calculate the behavior of a group of piles under lateral loading. The deflection of an isolated pile is determined by assuming the soil mass behaves as an elastic half space and by integrating Mindlin's equation. Interaction factors, $a_{kj}$, that represent the displacement of pile k due to a unit load on pile j, divided by the displacement of pile k due to its own unit load are calculated. Then, for each pile, an equation of the following form can be written:

$$\rho_G = \rho_H \left( \sum_{\substack{j=1 \\ j \neq k}}^{m} H_j \alpha_{kj} + H_k \right)$$

where

$\rho_G$ = pile group deflection

$\rho_H$ = deflection of an isolated pile under a unit load

$H_j$ = horizontal load on pile j

m = number of piles in the group

$a_{kj}$ = $\dfrac{\text{displacement of pile k due to pile j}}{\text{displacement of pile k due to its own load.}}$

Using these equations and an equation that states that the sum of the loads on each pile is equal to the total load on the group, DEFPIG solves for the load on each pile and the deflection of the group. The program allows the user to model local yielding of the soil and to use an elastic modulus that varies with depth. DEFPIG cannot provide the user with moment or deflection curves as a function of depth or the response of the group to cyclic loading.

For the DEFPIG analysis performed for these comparisons the modulus of elasticity of the soil was assumed to increase linearly with depth according to the equation

$$E_s = kx$$

where

$E_s$ = modulus of elasticity of the soil (psi)

k = a constant

x = depth below the ground surface (in.).

The measured load-deflection relationship for cycle 1 of the single-pile load test was used to obtain appropriate values of the parameter k to use in the analysis of the group. Shown in Fig. 6.1 is the measured load-deflection relationship for cycle 1 of the single-pile load tests and linear load-deflection relationships for various values of k. For each value of k the load was selected at which the measured single pile deflection matched the deflection calculated by the elastic analysis. These loads were then used with the corresponding values of k in DEFPIG to predict the behavior of the group of piles.

**Calculated Behavior of the Group of Piles Using Program DEFPIG with No Local Yielding for Static Loading**

The load vs. deflection curve calculated using DEFPIG is shown in Fig. 6.2 along with points representing measured loads and deflections for cycle 1 of the load test of the group of piles. In this case, the results of the DEFPIG analysis agree with the measured points for lower load levels, and overpredict deflections by up to about 18 percent for higher load levels.

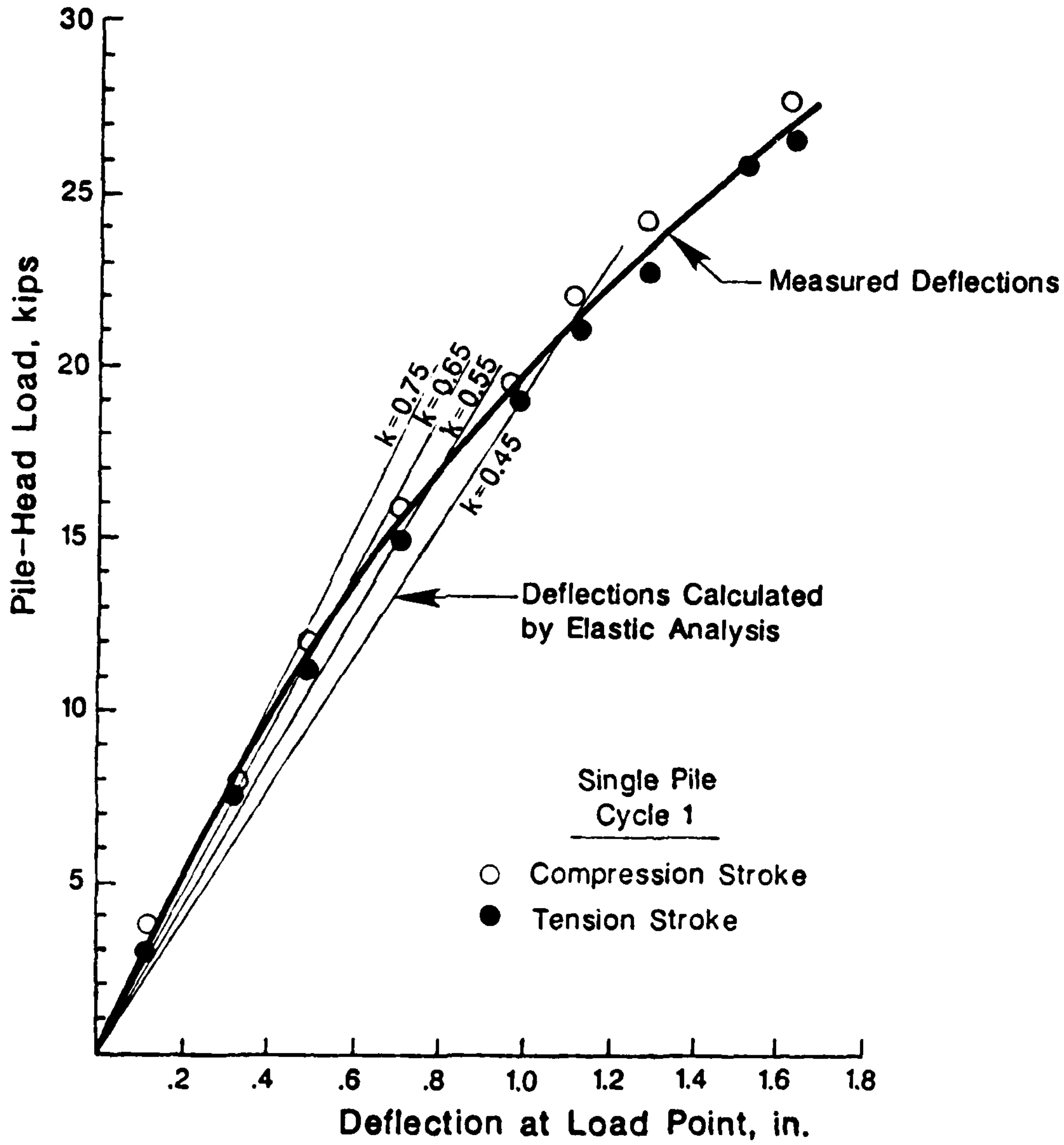


Fig. 6.1. Comparison of measured deflections with single-pile deflections computed by elastic analysis.

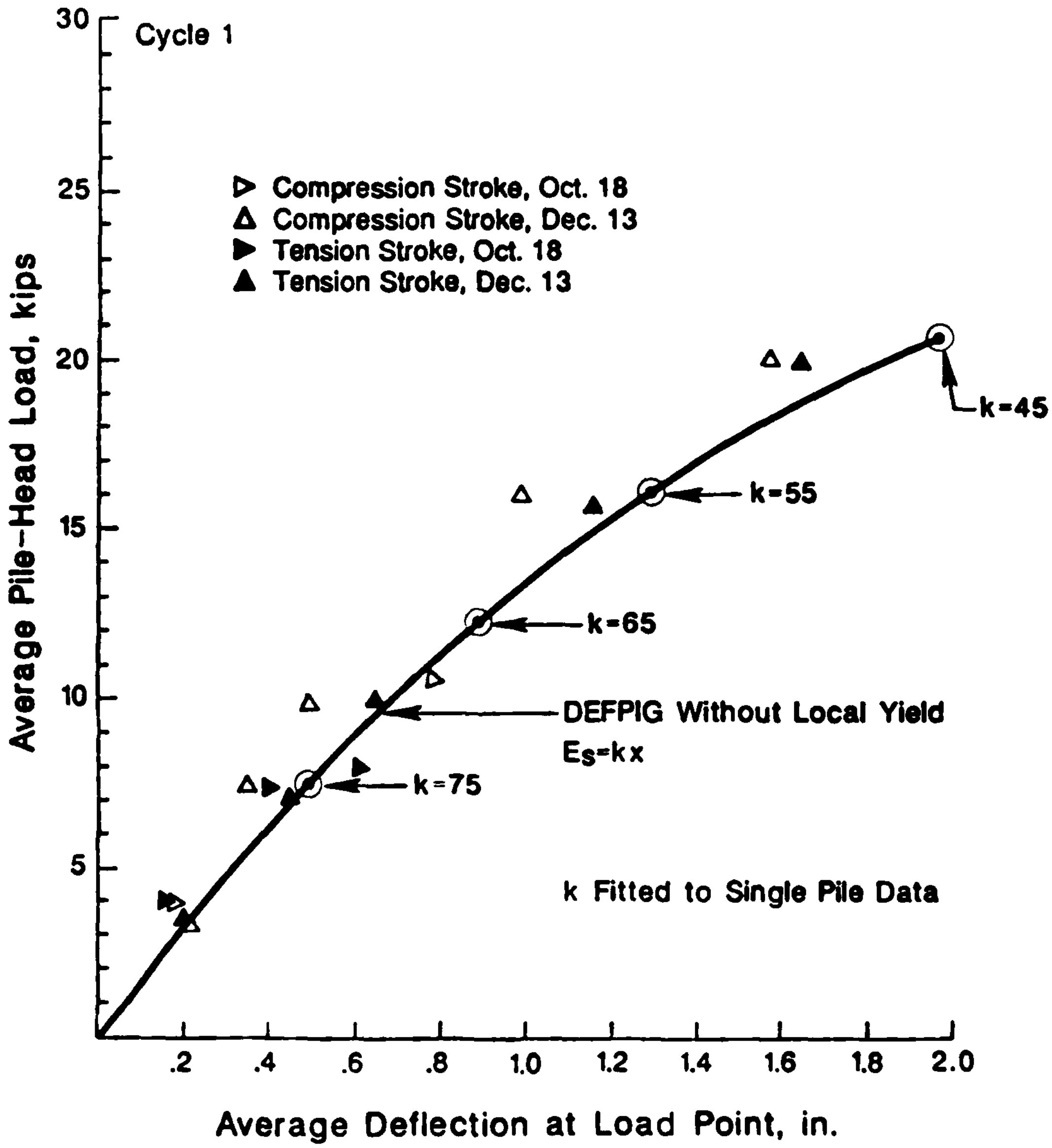


Fig. 6.2. Comparison of measured deflections with deflections computed by DEFPIG without local yield.

The distribution of the load to the piles in the group calculated with program DEFPIG is compared with typical measured load distributions and shown in Figs. 6.3 and 6.4. The measured load distribution shows that the leading row of piles takes the largest portion of the load, and the trailing row takes the smallest portion. The load distribution calculated with DEFPIG indicates that the leading and trailing rows of piles take the same portion of the load applied to the group while the middle row takes a smaller portion. The DEFPIG distribution also indicates that the corner piles take the largest load and the center pile takes the smallest load.

**Calculated Behavior of the Group of Piles Using Program DEFPIG with Local Yielding for Static Loading**

For the calculation of the behavior of the group of piles using DEFPIG with local yielding, the modulus of elasticity of the soil was assumed to vary linearly according to the equation

$$E_s = 75x$$

where

$E_s$ = modulus of elasticity of the soil, psi

$x$ = depth below ground surface, in.

The pressures at which the soil was assumed to yield correspond to the maximum soil pressures calculated

**Measured Load Distribution**
**Compression Stroke Cycle 1**
**Load = 66$^k$ (7.34 $^k$/pile)**

| | | | | Portion of Load Taken by Each Row |
|---|---|---|---|---|
| Leading Row | 1.16 | 1.25 | 1.26 | 41% |
| Middle Row | 1.10 | 1.21 | 0.83 | 35% |
| Trailing Row | 1.01 | 0.53 | 0.66 | 24% |

**Load Distribution Calculated**
**by DEFPIG $E_s$ = 75x**

| | | | Portion of Load Taken by Each Row |
|---|---|---|---|
| 1.09 | 0.96 | 1.09 | 35% |
| 0.96 | 0.80 | 0.96 | 30% |
| 1.09 | 0.96 | 1.09 | 35% |

**Values shown represent the pile-head load divided by the average pile-head load.**

Fig. 6.3. Comparison of measured load distribution with load distribution computed by DEFPIG without local yield.

**Measured Load Distribution**
**Compression Stroke Cycle 1**
**Load = 179 $^k$ (19.94 $^k/_{pile}$)**

| | | | | Portion of Load Taken by Each Row |
|---|---|---|---|---|
| Leading Row | 1.26 | 1.28 | 1.34 | 43 % |
| Middle Row | 1.03 | 1.10 | 0.85 | 33 % |
| Trailing Row | 0.87 | 0.59 | 0.68 | 24 % |

**Load Distribution Calculated**
**by DEFPIG $E_s$ = 45x**

| | | | Portion of Load Taken by Each Row |
|---|---|---|---|
| 1.09 | 0.96 | 1.09 | 35 % |
| 0.96 | 0.80 | 0.96 | 30 % |
| 1.09 | 0.96 | 1.09 | 35 % |

**Values shown represent the pile-head load divided by the average pile-head load.**

Fig. 6.4. Comparison of measured load distribution with load distribution computed by DEFPIG without local yield (continued).

according to the modified Reese, Cox and Koop procedure described in Chapter 5.

The load vs. deflection curve calculated using DEFPIG with local yielding is shown in Fig. 6.5 along with points representing measured loads and deflections for cycle 1 of the load test of the group of piles. The agreement is quite good.

The distribution of the load to the piles in the group calculated with DEFPIG using local yielding is compared with typical measured load distributions as shown in Figs 6.6 and 6.7. Including local yielding in the DEFPIG calculation does not change the load distribution much. The comments made on the distribution of load calculated with DEFPIG without local yielding also apply to the distribution calculated with local yielding.

**Summary**

Program DEFPIG appears to be useful for calculating the load-vs.-deflection relationship for a group of piles under lateral load. The distribution of the load to the piles in the group calculated using DEFPIG does not correspond well with the distribution of load measured in the load test described herein. The maximum moment in the group of piles cannot be calculated with

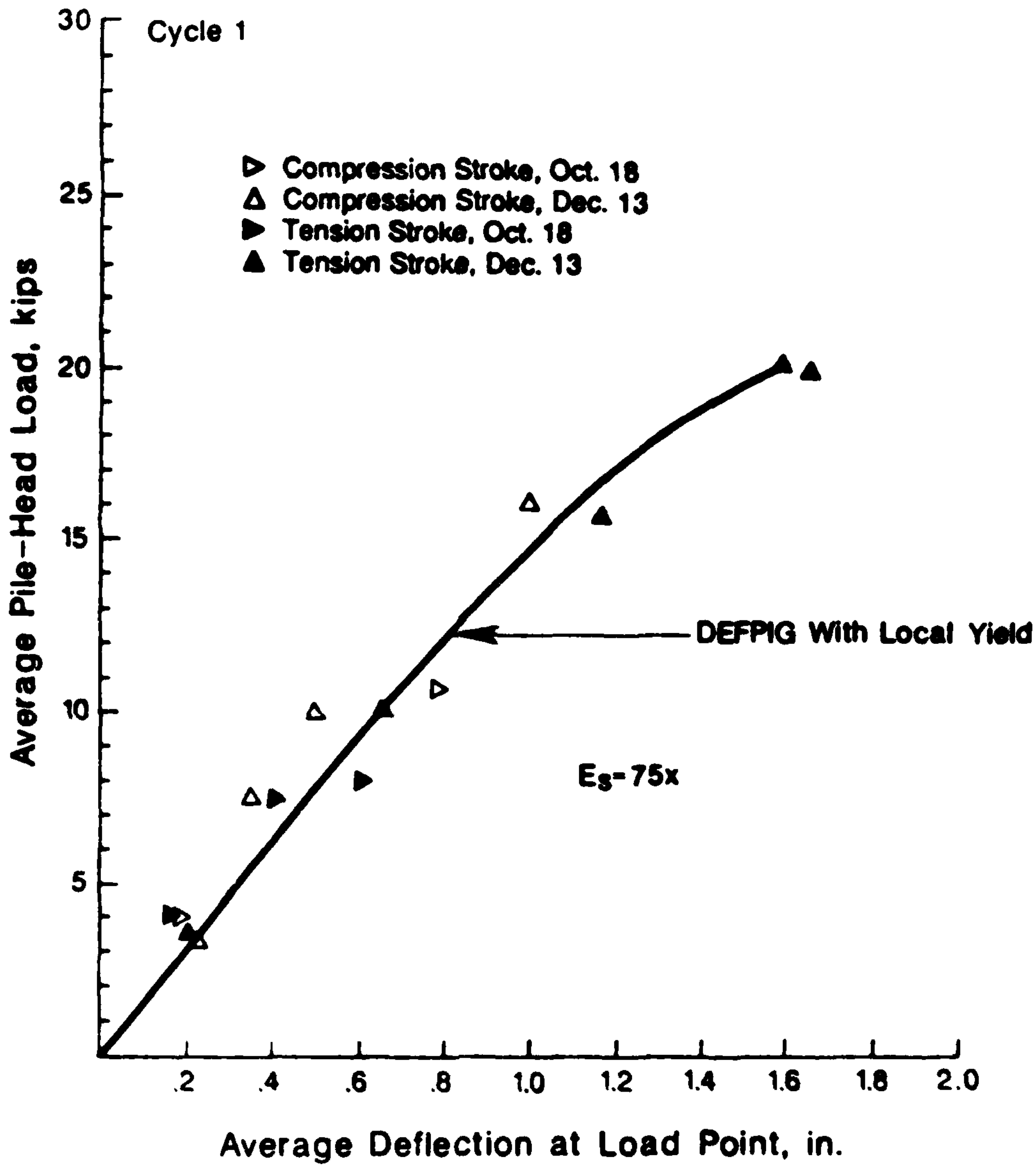


Fig. 6.5. Comparison of measured deflections with deflections computed by DEFPIG with local yield.

Measured Load Distribution
Compression Stroke Cycle 1
Load = $66^k$ ($7.34\ ^k/_{pile}$)

| | | | | Portion of Load Taken by Each Row |
|---|---|---|---|---|
| Leading Row | 1.16 | 1.25 | 1.26 | 41 % |
| Middle Row | 1.10 | 1.21 | 0.83 | 35% |
| Trailing Row | 1.01 | 0.53 | 0.66 | 24% |

Load Distribution Calculated
by DEFPIG with Local Yield.
Load = $72^k$ ( $8.00\ ^k/_{pile}$ )

| | | | Portion of Load Taken by Each Row |
|---|---|---|---|
| 1.09 | 0.96 | 1.09 | 35% |
| 0.96 | 0.80 | 0.96 | 30% |
| 1.09 | 0.96 | 1.09 | 35% |

Values shown represent the pile-head load
divided by the average pile-head load.

Fig. 6.6. Comparison of measured load distribution with load distribution computed by DEFPIG with local yield.

**Measured Load Distribution**
**Compression Stroke Cycle 1**
**Load = 179$^k$ (19.94 $^k$/pile)**

| | | | | Portion of Load Taken by Each Row |
|---|---|---|---|---|
| Leading Row | 1.26 | 1.28 | 1.34 | 43% |
| Middle Row | 1.03 | 1.10 | 0.85 | 33% |
| Trailing Row | 0.87 | 0.59 | 0.68 | 24% |

**Load Distribution Calculated**
**by DEFPIG with Local Yield**
**Load = 180$^k$(20.0$^k$/pile)**

| | | | Portion of Load Taken by Each Row |
|---|---|---|---|
| 1.09 | 0.96 | 1.09 | 35% |
| 0.96 | 0.80 | 0.96 | 30% |
| 1.09 | 0.96 | 1.09 | 35% |

**Values shown represent the pile-head load divided by the average pile-head load.**

Fig. 6.7. Comparison of measured load distribution with load distribution computed by DEFPIG with local yield (continued).

DEFPIG, and the cyclic loading case cannot be considered with DEFPIG.

**FOCHT-KOCH METHOD**

Focht and Koch (1973) presented a method of calculating the behavior of a group of piles that combined analysis of a single pile using a nonlinear p-y curve with the elastic-group interaction described by Poulos. In the Focht-Koch method the deflection of a single pile under a given horizontal load is determined both by using p-y curves and the elastic half-space analysis of Poulos. A relative stiffness factor is then calculated according to

$$R = Y_S/p_H$$

where

$R$ = relative stiffness factor

$Y_S$ = deflection of an isolated pile calculated by p-y analysis

$p_H$ = deflection for an isolated pile calculated by elastic analysis

Then for each pile an equation can be written

$$\rho_G = \rho_H \left( \sum_{\substack{j=1 \\ j \neq k}}^{m} H_j \alpha_{kj} + RH_k \right)$$

where

$p_G$ = pile group deflection

$H_j$ = horizontal load on pile j

$$\alpha_{kj} = \frac{\text{displacement of pile k due to pile j}}{\text{displacement of pile k due to its own load}}$$

$m$ = number of piles in the group.

Using these equations and an equation that states that the sum of the loads on each pile is equal to the total load on the group, the load on each pile and the deflection of the group can be found. The curves for moment and deflection for the pile with the largest load can then be calculated by multiplying the deflection values of the p-y curves used in the analysis of the isolated pile by a constant, $y_{mult}$, such that the pile-head deflection computed with the resultant p-y curves is equal to the deflection of the group. This constant is found by successive trials.

## Calculated Behavior of the Group of Piles Using the Focht-Koch Method for Static Loading

The load vs. deflection curve for static loading calculated using the Focht-Koch method is shown in Fig. 6.8 along with points representing measured loads and deflections for cycle 1 of the load test of the group of piles. In this case the agreement between calculated and measured deflection is good.

The curve of load vs. maximum moment for static loading calculated using the Focht-Koch method is shown in Fig. 6.9, along with points representing the measured

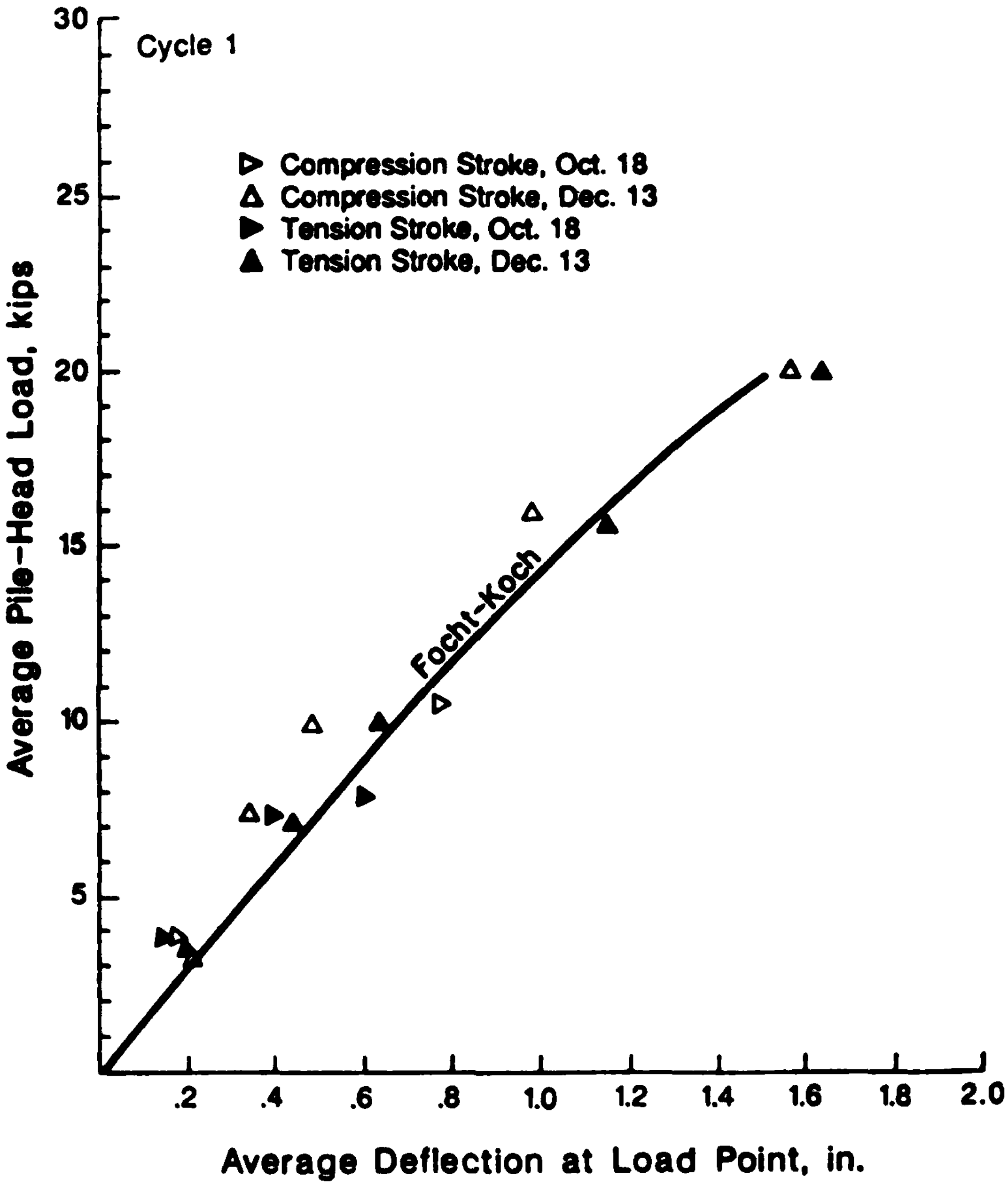


Fig. 6.8. Comparison of measured deflections with static deflections computed by the Focht-Koch method .

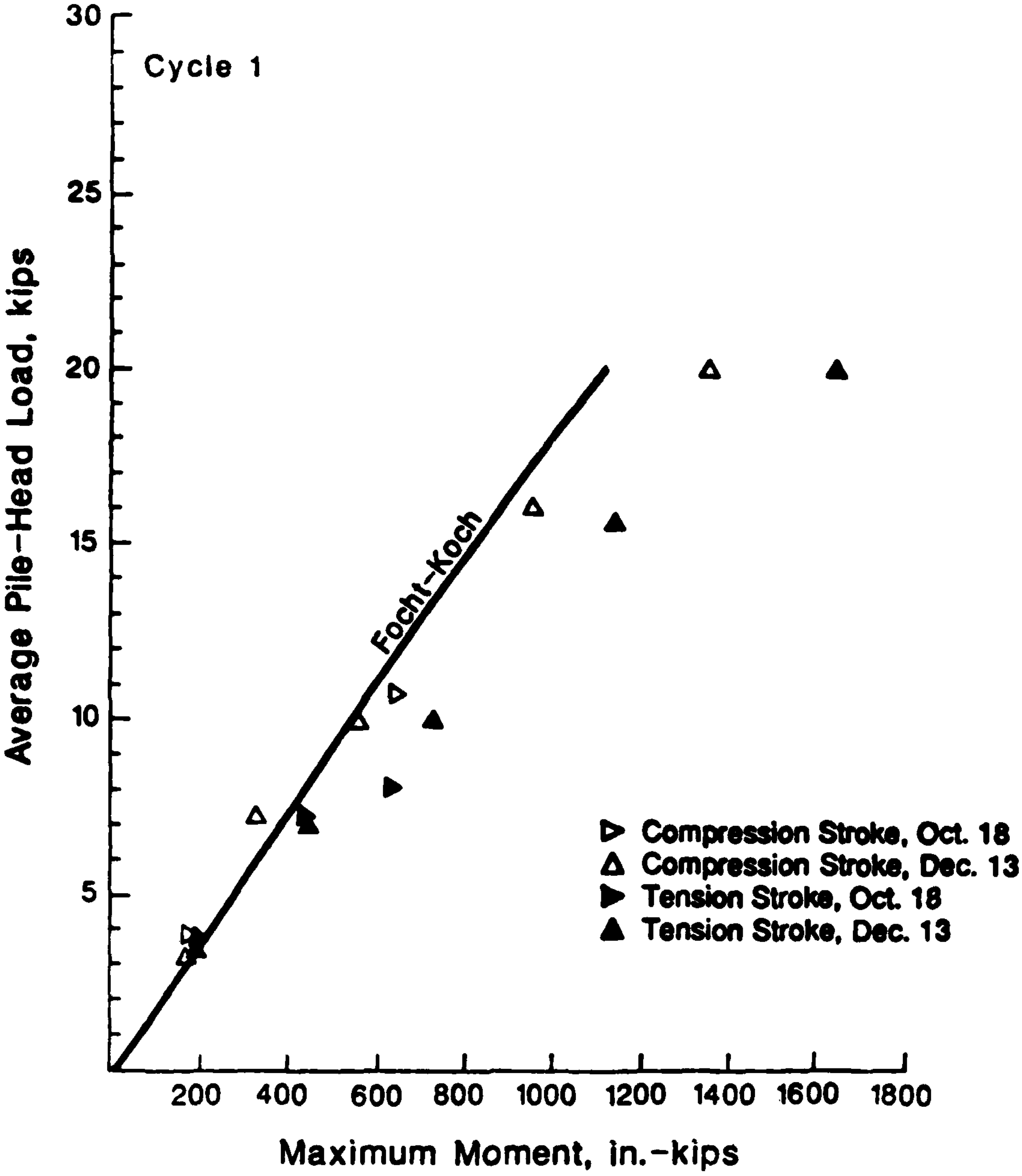


Fig. 6.9. Comparison of measured maximum moments with static maximum moments computed by the Focht-Koch method.

maximum moments and loads for cycle 1 of the load test of the group of piles. The agreement between calculated and measured maximum moment is good for lower load levels. For higher levels the Focht-Koch method underpredicted moments by up to 47 percent. The higher moments may be due in part to the rotation of the pile group around a vertical axis as the load test proceeded.

The distribution of the load to the piles in the group calculated by the Focht-Koch method is compared with typical measured load distributions for static loading in Fig. 6.10 and 6.11. The measured load distribution shows that the leading row of piles takes the largest portion of the load, and the trailing row takes the smallest portion. The load distribution calculated using the Focht-Koch method shows a pattern similar to that calculated with DEFPIG: the outside piles take a larger load than the interior pile, and the distribution is more nearly uniform than the measured distribution.

## Calculated Behavior of the Group of Piles Using the Focht-Koch Method for Cyclic Loading

The load-vs.-deflection curve for cyclic loading calculated using the Focht-Koch method is shown in Fig. 6.12 along with points representing measured loads and deflections for cycle 100 of the load test of the group.

Measured Load Distribution
Compression Stroke Cycle 1
Load = 66 $^k$ (7.34 $^k$/ pile)

| | | | | Portion of Load Taken by Each Row |
|---|---|---|---|---|
| Leading Row | 1.16 | 1.25 | 1.26 | 41% |
| Middle Row | 1.10 | 1.21 | 0.83 | 35% |
| Trailing Row | 1.01 | 0.53 | 0.66 | 24% |

Load Distribution Calculated by
Focht & Koch Method
Load = 72 $^k$ (8.00 $^k$/pile ) Static Load

| | | | Portion of Load Taken by Each Row |
|---|---|---|---|
| 1.08 | 0.97 | 1.08 | 35% |
| 0.96 | 0.82 | 0.96 | 30% |
| 1.08 | 0.97 | 1.08 | 35% |

Values shown represent the pile-head load divided by the average pile-head load.

Fig. 6.10. Comparison of measured load distribution with load distribution computed by the Focht-Koch method.

Measured Load Distribution
Compression Stroke Cycle 1
Load = 179$^k$ (19.94 $^k$/pile)

| | | | | Portion of Load Taken by Each Row |
|---|---|---|---|---|
| Leading Row | 1.26 | 1.28 | 1.34 | 43% |
| Middle Row | 1.03 | 1.10 | 0.85 | 33% |
| Trailing Row | 0.87 | 0.59 | 0.68 | 24% |

Load Distribution Calculated by
Focht & Koch Method
Load = 180$^k$ (20 $^k$/pile ) Static Load

| | | | Portion of Load Taken by Each Row |
|---|---|---|---|
| 1.07 | 0.97 | 1.07 | 35% |
| 0.96 | 0.86 | 0.96 | 30% |
| 1.07 | 0.97 | 1.07 | 35% |

Values shown represent the pile-head load divided by the average pile-head load.

Fig. 6.11. Comparison of measured load distribution with load distribution computed by the Focht-Koch method (continued).

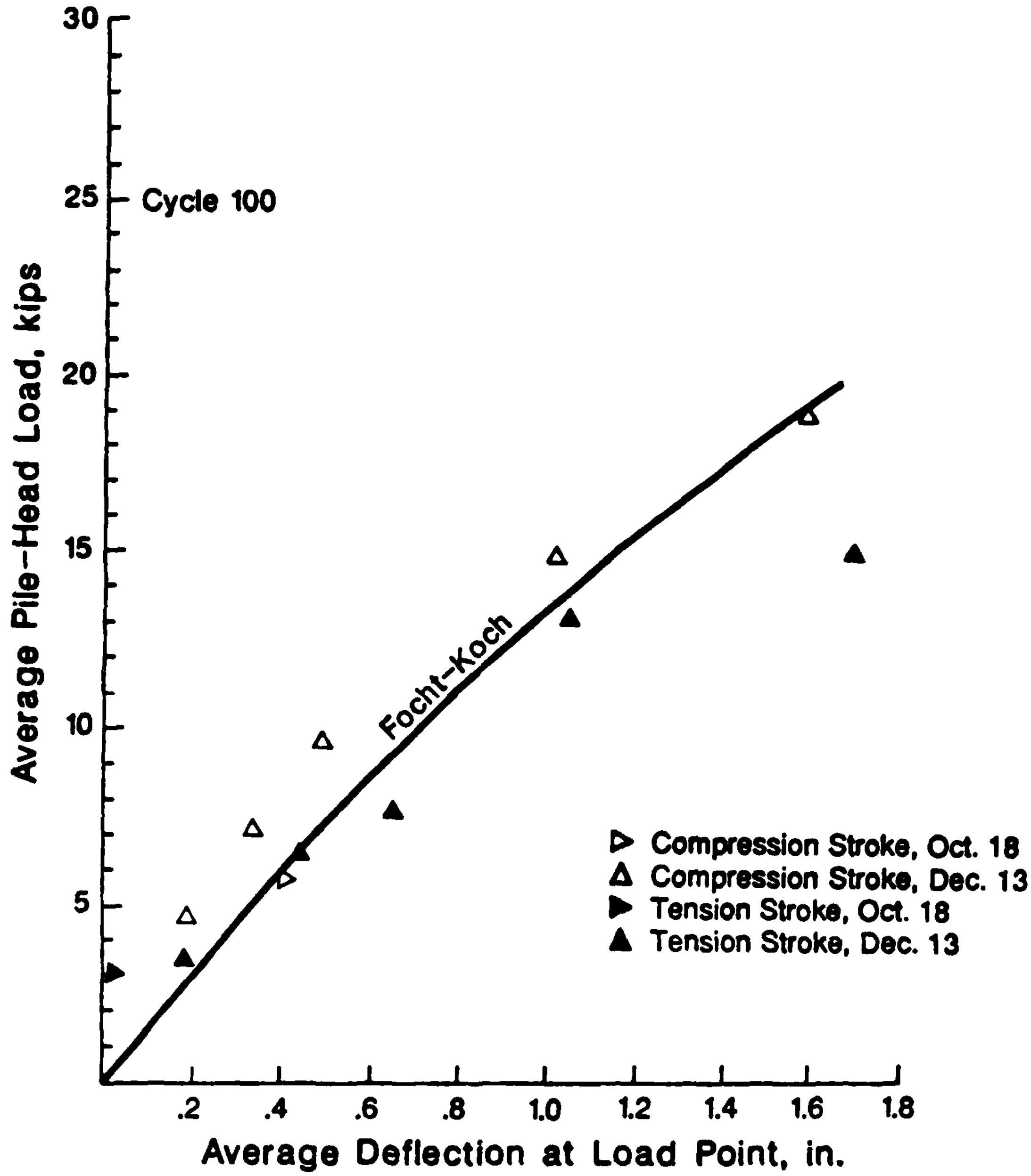


Fig. 6.12. Comparison of measured deflections with cyclic deflections computed by the Focht-Koch method.

In this case the agreement between the calculated and measured deflections is good.

The curve for the load vs. maximum moment for cyclic loading from the Focht-Koch method is shown in Fig. 6.13 along with points representing the measured maximum moments and loads for cycle 100 of the load test. The agreement between measured and calculated maximum moments is good for low levels of load. For the higher loads, the Focht-Koch method underpredicted moments by up to 75 percent. Again, the higher measured moments may be due in part to the rotation of the pile group around a vertical axis as the load test proceeded.

The distribution of the load to the piles in the group from the Focht-Koch method is compared with typical measured distributions for cyclic loading and is shown in Figs. 6.14 and 6.15. The measured loads show the leading row taking a larger portion of the load. The calculated loads show a more uniform distribution.

**Summary**

The curve of load vs. deflection calculated using the Focht-Koch method agreed relatively well with the measured deflections of the group. Maximum moments calculated with the Focht-Koch method were smaller than the measured values at higher load levels. The

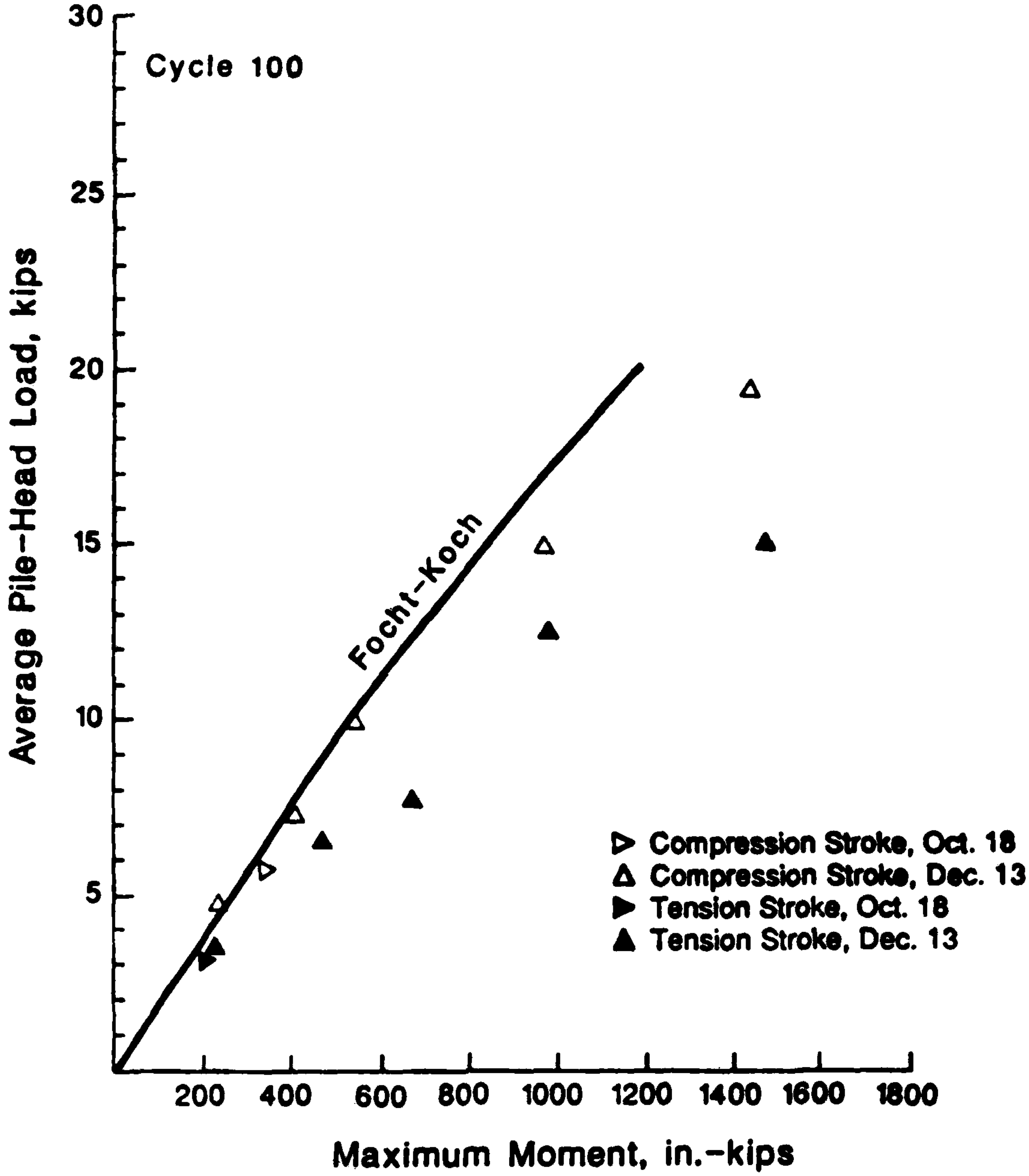


Fig. 6.13. Comparison of measured maximum moments with cyclic maximum moments computed by the Focht-Koch method.

**Measured Load Distribution**
**Compression Stroke Cycle 100**
**Load = $65^{k}$($7.20^{k}$/pile)**

| | | | | Portion of Load Taken by Each Row |
|---|---|---|---|---|
| Leading Row | 1.17 | 1.28 | 1.34 | 42% |
| Middle Row | 1.08 | 1.22 | 0.81 | 35% |
| Trailing Row | 1.00 | 0.48 | 0.62 | 23% |

**Load Distribution Calculated by**
**Focht & Koch Method**
**Load = $72^{k}$($8.00^{k}$/pile) Cyclic Load**

| | | | Portion of Load Taken by Each Row |
|---|---|---|---|
| 1.08 | 0.96 | 1.08 | 35% |
| 0.96 | 0.83 | 0.96 | 30% |
| 1.08 | 0.96 | 1.08 | 35% |

**Values shown represent the pile-head load divided by the average pile-head load.**

Fig. 6.14. Comparison of measured load distribution with load distribution computed by the Focht-Koch method.

Measured Load Distribution
Compression Stroke Cycle 100
Load = $174^{k}$ ($19.30^{k}$/ pile)

| | | | Portion of Load Taken by Each Row |
|---|---|---|---|
| 1.28 | 1.28 | 1.39 | 44 % |
| 1.00 | 1.10 | 0.83 | 33 % |
| 0.85 | 0.59 | 0.68 | 23 % |

Load Distribution Calculated by
Focht & Koch Method
Load = $180^{k}$ ($20.00^{k}$ / pile) Cyclic Load

| | | | Portion of Load Taken by Each Row |
|---|---|---|---|
| 1.06 | 0.98 | 1.06 | 34 % |
| 0.97 | 0.87 | 0.97 | 31 % |
| 1.06 | 0.98 | 1.06 | 34 % |

Values shown represent the pile-head load divided by the average pile-head load.

Fig. 6.15. Comparison of measured load distribution with load distribution computed by the Focht-Koch method (continued).

distribution of loads to piles in the group calculated with the Focht-Koch method was much more uniform than the distributions that were measured.

**SINGLE-PILE METHOD**

Reese (1984) presented a method of calculating the behavior of a group of piles that was intended to establish an upper bound on the pile group deflection and bending moment. In this method, p-y curves are generated for an imaginary pile according to standard procedures. The diameter of the imaginary pile is taken as the circumference of the group divided by $\pi$. The stiffness of the imaginary pile is taken as the sum of the stiffnesses of the individual piles. The shear and moments obtained from the analysis of the imaginary pile are then distributed equally among the piles in the group (assuming all piles in the group have the same stiffness). The deflection of the group is taken to be equal to the deflection of the imaginary pile.

**Calculated Behavior of the Group of Piles Using the Single-Pile Method for Static Loading**

The curve of load vs. deflection for static loading, calculated using the single-pile method, is shown in Fig. 6.16 along with points representing measured loads and deflections for cycle 1 of the load test of the group.

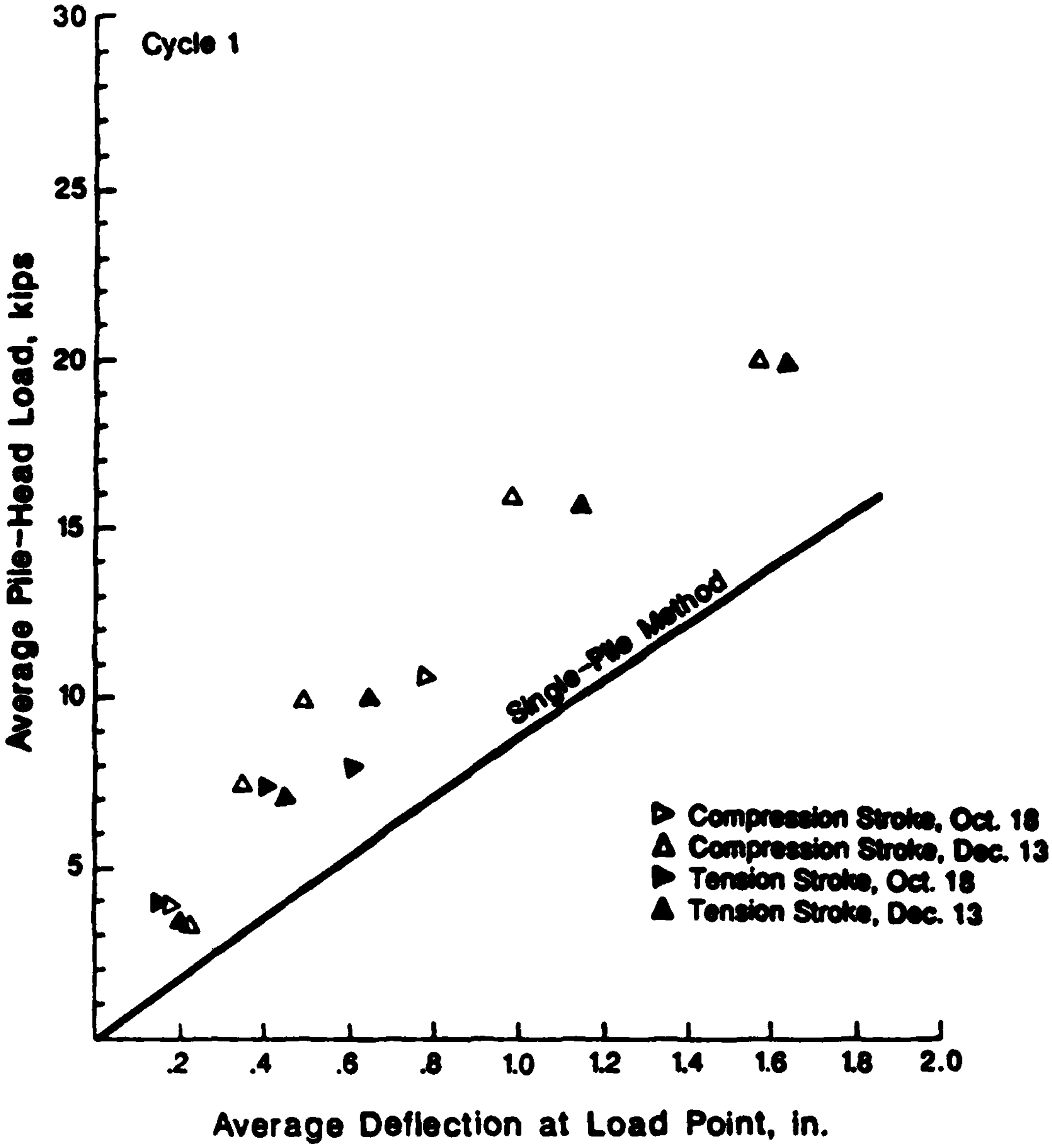


Fig. 6.16. Comparison of measured deflections with static deflections computed by the single pile method.

In this case, the single-pile method significantly overpredicted the measured deflections.

The curve of load vs. maximum moment for static loading, calculated using the single-pile method, is shown in Fig. 6.17 along with points representing measured maximum moments for cycle 1 of the load test of the group. The agreement between calculated and measured maximum moments is good for low levels of load, but the single-pile method underpredicted measured maximum moments for higher loads.

The single-pile method assumes that the load on the group is uniformly distributed among the individual piles. This does not agree with the measured distribution of load.

### Calculated Behavior of the Group of Piles Using the Single-Pile Method for Cyclic Loading

The curve of load vs. deflection for cyclic loading, calculated using the single-pile method, is shown in Fig. 6.18 along with points representing measured loads and deflections for cycle 100 of the load test of the group. The single-pile method overpredicted deflections for all load levels.

The curve of load vs. maximum moment for cyclic loading, calculated using the single-pile method, is shown in Fig. 6.19 along with points representing measured

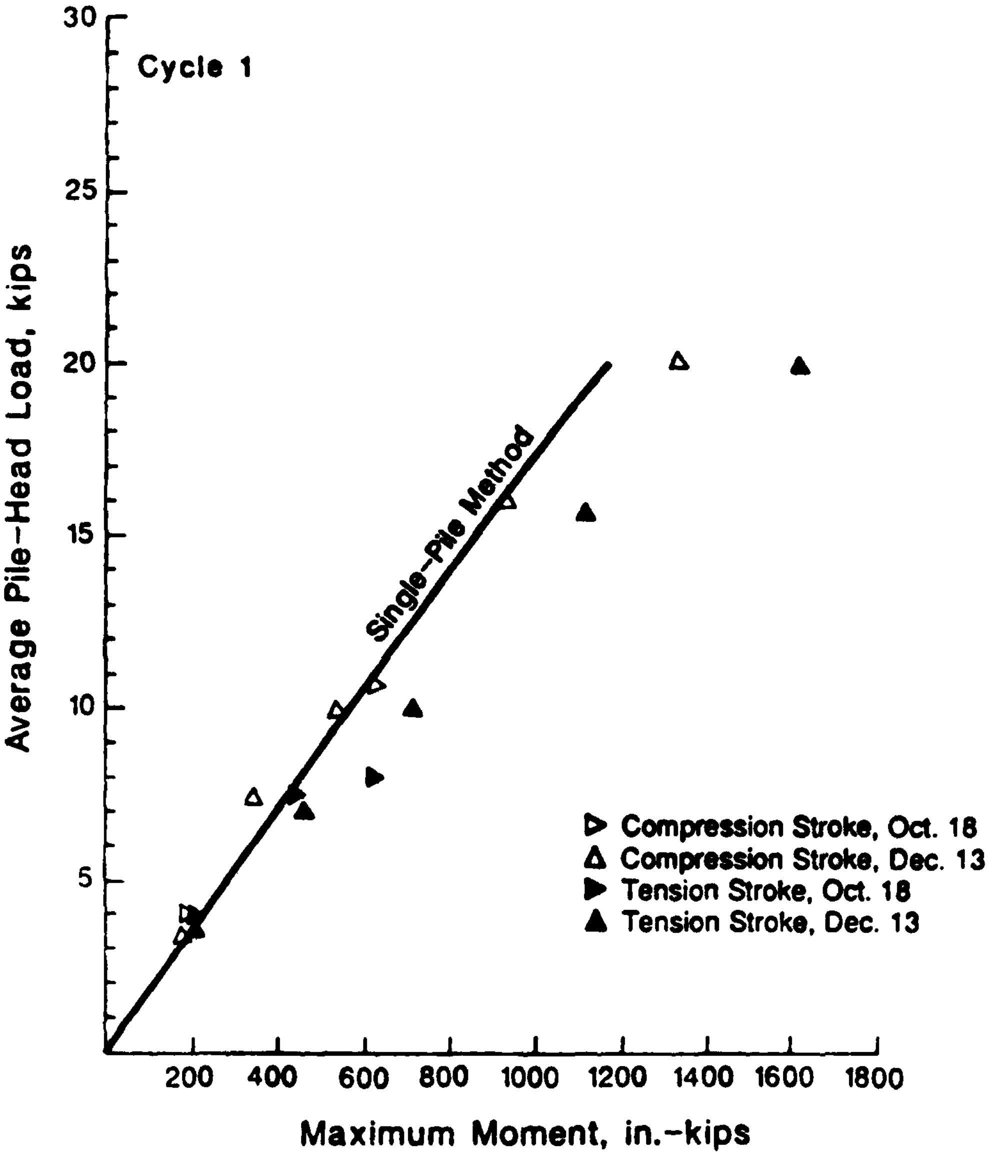


Fig. 6.17. Comparison of measured maximum moments with static maximum moments computed by the single pile method.

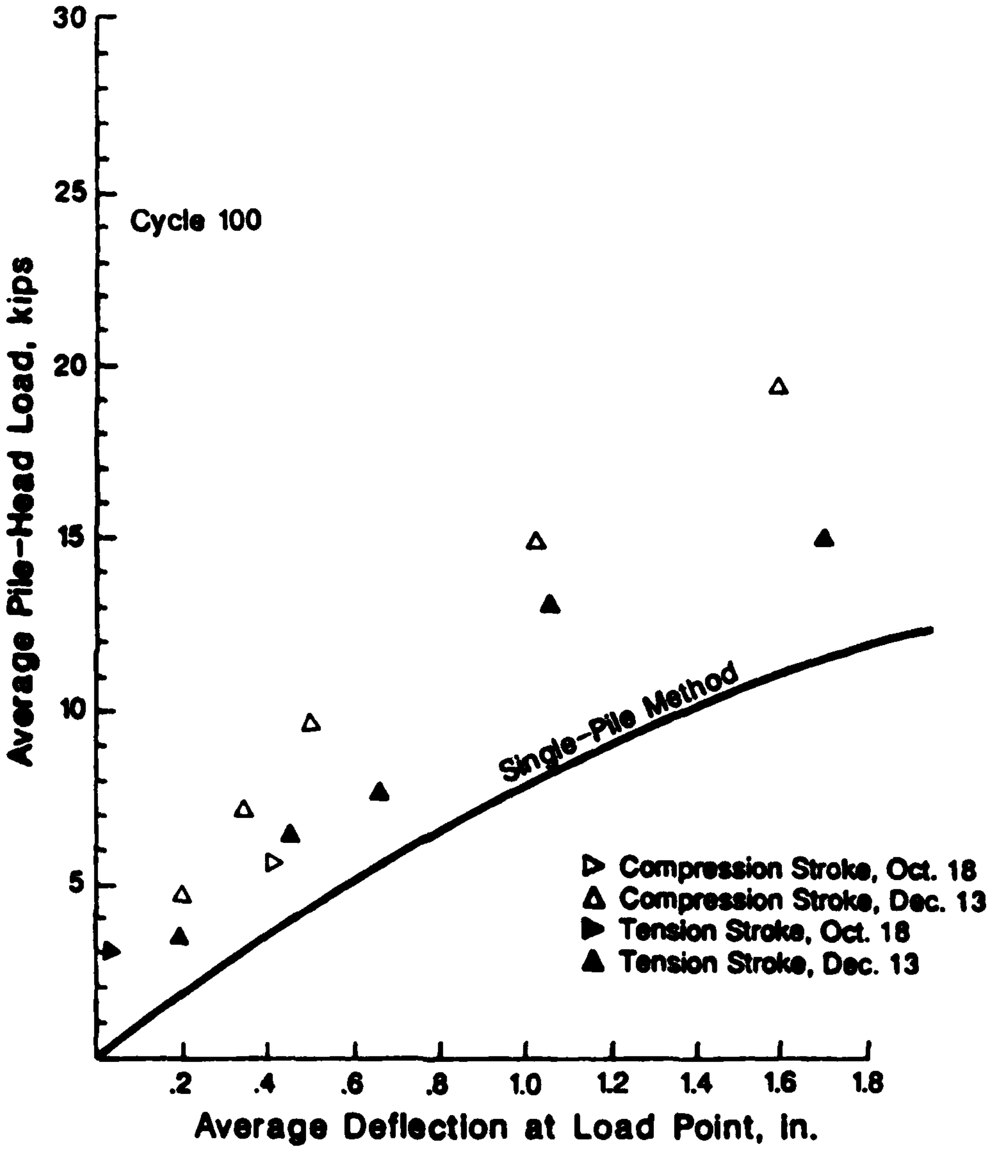


Fig. 6.18. Comparison of measured deflections with cyclic deflections computed by the single-pile method.

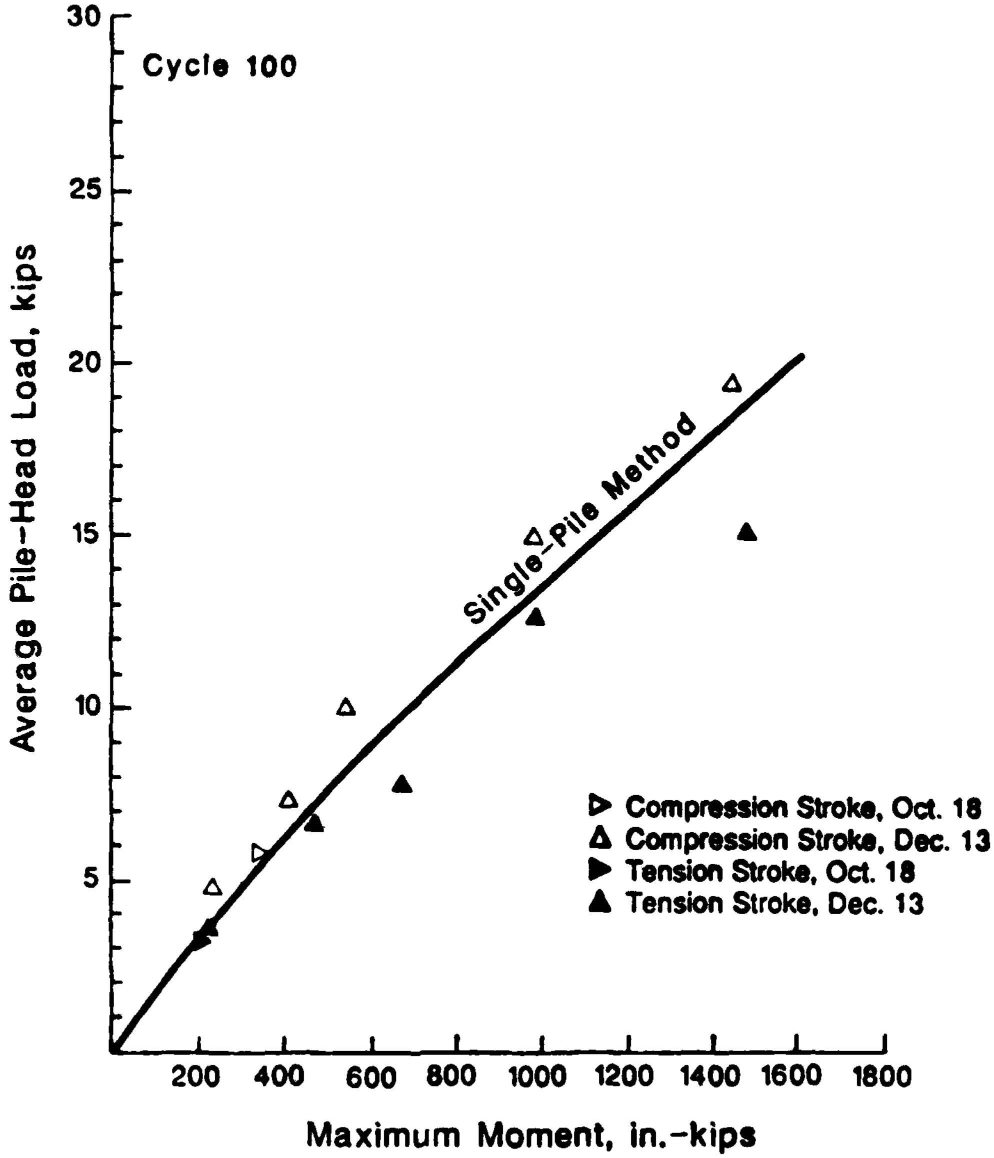


Fig. 6.19. Comparison of measured maximum moments with cyclic maximum moments computed by the single-pile method.

maximum moments for cycle 100 of the load test of the group. In this case the agreement between calculated and measured maximum moments is good.

**Summary**

For static loading, the single-pile method overpredicted measured deflections. The method showed good agreement with measured maximum moments for low levels of load but underpredicted maximum moments at higher levels of load. For cyclic loading, the single-pile method overpredicted measured deflections, but showed good agreement with measured maximum moments. The single-pile method assumes a uniform distribution of load to the individual piles. This does not agree with the measured behavior of the group.

## BOGARD-MATLOCK METHOD

Bogard and Matlock (1983) presented a method of calculating the behavior of a group of piles that combined the behavior of an isolated pile with the behavior of a large imaginary pile, similar to that defined in the single-pile method. In this method p-y curves are generated for an isolated pile according to a standard procedure. Also, p-y curves are generated for an imaginary pile in the same way as specified previously for the single-pile method. The p-y curves for the imaginary

pile are modified by dividing the soil resistance, p, by the number of piles in the group and dividing the deflection, y, by the pile spacing expressed in pile diameters. The p-y curves for the individual pile are then combined with the modified p-y curves for the imaginary pile by adding the two values of deflection for a corresponding soil resistance value. The maximum soil resistance is the smaller value of the two curves. The method of generating these p-y curves is demonstrated in Fig. 6.20. The load in the group is assumed to be distributed equally among the piles in the group. The deflection of a pile in the group, and its moment curve can be obtained using the derived p-y curves.

For cyclic loading, Bogard and Matlock recommended generating the modified p-y curves for the imaginary pile with a procedure for static loading. Bogard and Matlock developed their method using the results of an experiment with a group of piles in soft clay, where the degradation of soil response due to cyclic loading is due primarily to the formation of a gap around an individual pile. In sand, the changes in the response of the soil due to cyclic loading are due either to a change in the density of the sand or a change in the state of stress in the soil mass. Both these changes can extend some distance away from an individual pile and affect the

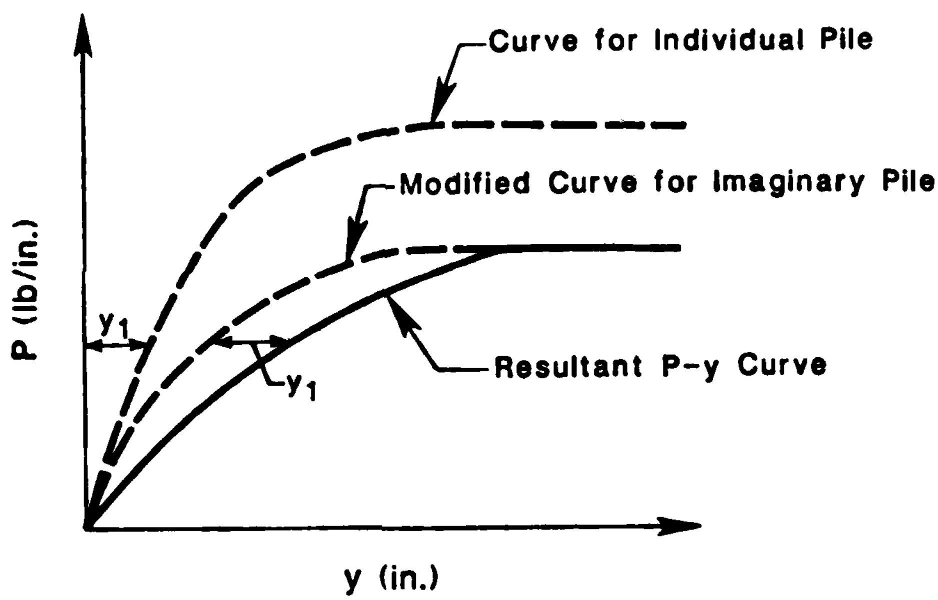


Fig. 6.20. Construction of p-y curves by the method of Bogard and Matlock (after Bogard and Matlock, 1983).

behavior of the group as a whole. For this reason, the results of cycle 100 of this load test are compared to the results of the Bogard-Matlock method using both a static and cyclic procedure to generate the modified p-y curves for the imaginary pile.

## Calculated Behavior of the Group of Piles Using the Bogard-Matlock Method for Static Loading

The curve of load vs. deflection for static loading is shown in Fig. 6.21 along with points representing measured loads and deflections for cycle 1 of the load test of the group. In this case, the Bogard-Matlock method slightly overpredicts the measured deflections.

The curve of load vs. maximum moment for static loading, calculated using the Bogard-Matlock method, is shown in Fig. 6.22 along with points representing measured maximum moments for cycle 1 of the load test of the group. The Bogard-Matlock method underpredicted the measured maximum moments by up to 48%. The higher measured moments may be due in part to the rotation of the pile group around a vertical axis as the test proceeded.

The Bogard-Matlock method assumes that the load on the group is uniformly distributed among the individual piles. This does not agree with the measured distribution of load.

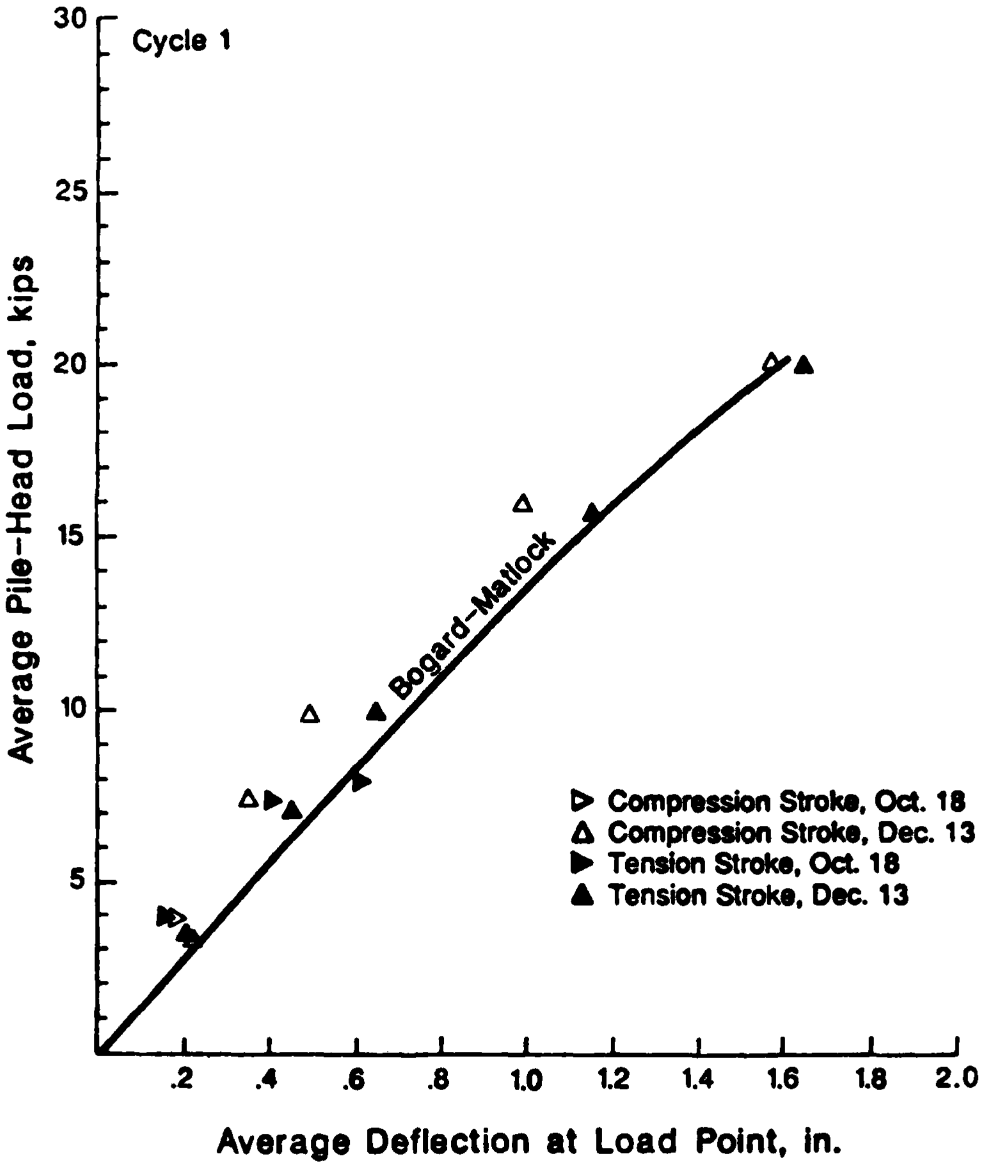


Fig. 6.21. Comparison of measured deflections with static deflections computed by the Bogard-Matlock method.

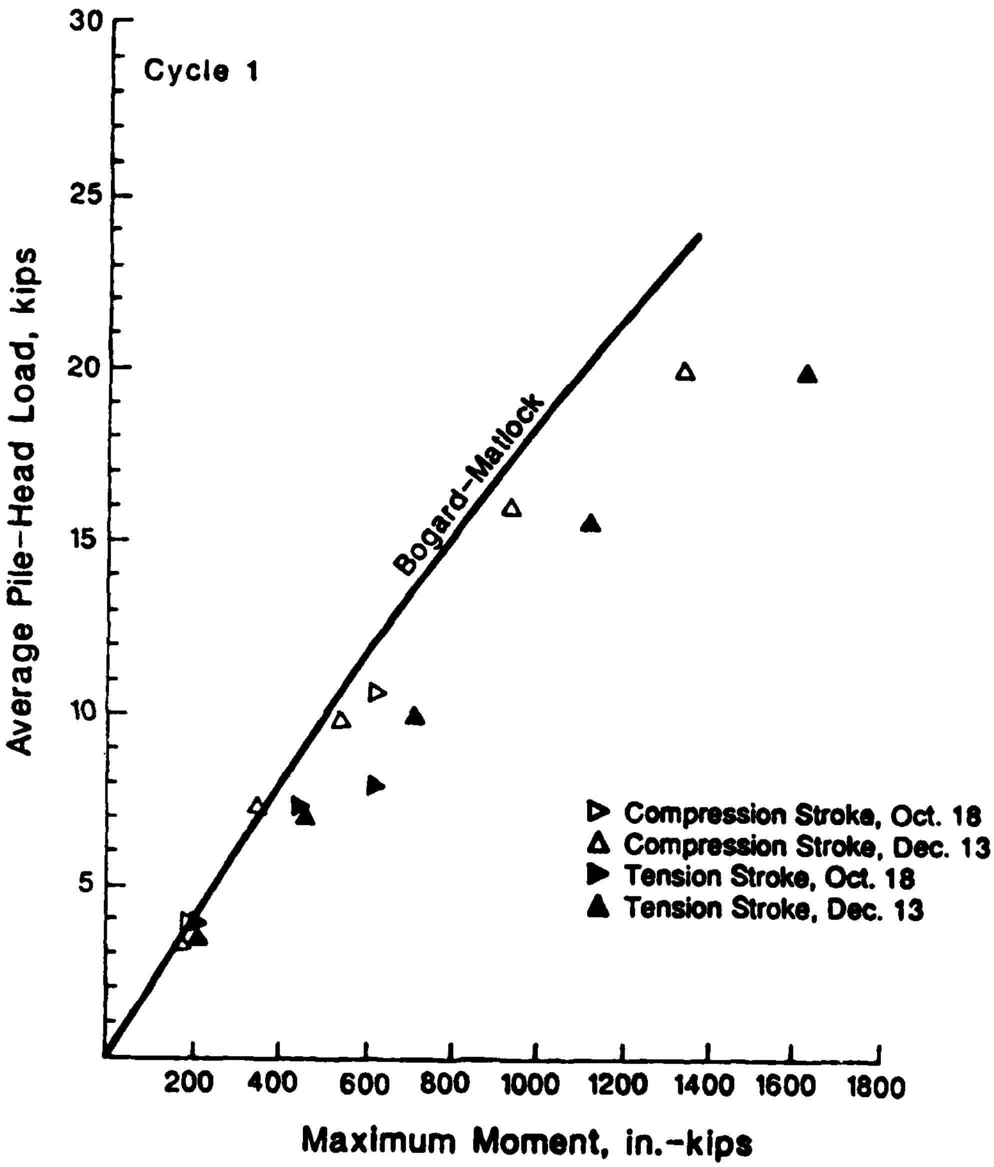


Fig. 6.22. Comparison of measured maximum moments with static maximum moments computed by the Bogard-Matlock method.

**Calculated Behavior of the Group of Piles Using the Bogard-Matlock Method for Cyclic Loading**

The curves of load vs. deflection for cyclic loading, calculated with the Bogard-Matlock method, using both static and cyclic procedures to generate the modified p-y curves for the imaginary pile, are shown in Fig. 6.23 along with points representing measured loads and deflections for cycle 100 of the load test of the group. The Bogard-Matlock method, using either procedure to generate modified p-y curves for the imaginary pile, overpredicts deflections at lower load levels. When the static procedure is used to generate p-y curves for the imaginary pile, there is good agreement between measured and calculated deflections at higher load levels. When the cyclic procedure is used, the method overpredicts the measured deflections.

The curves of load vs. maximum moment for cyclic loading, calculated with the Bogard-Matlock method, using both static and cyclic procedures to generate modified p-y curves for the imaginary pile, are shown in Fig. 6.24 along with points representing measured maximum moments for cycle 100 of the load test of the group. In this case, the Bogard-Matlock method, using the static procedure to generate modified p-y curves for the imaginary pile, underpredicts measured maximum moments by

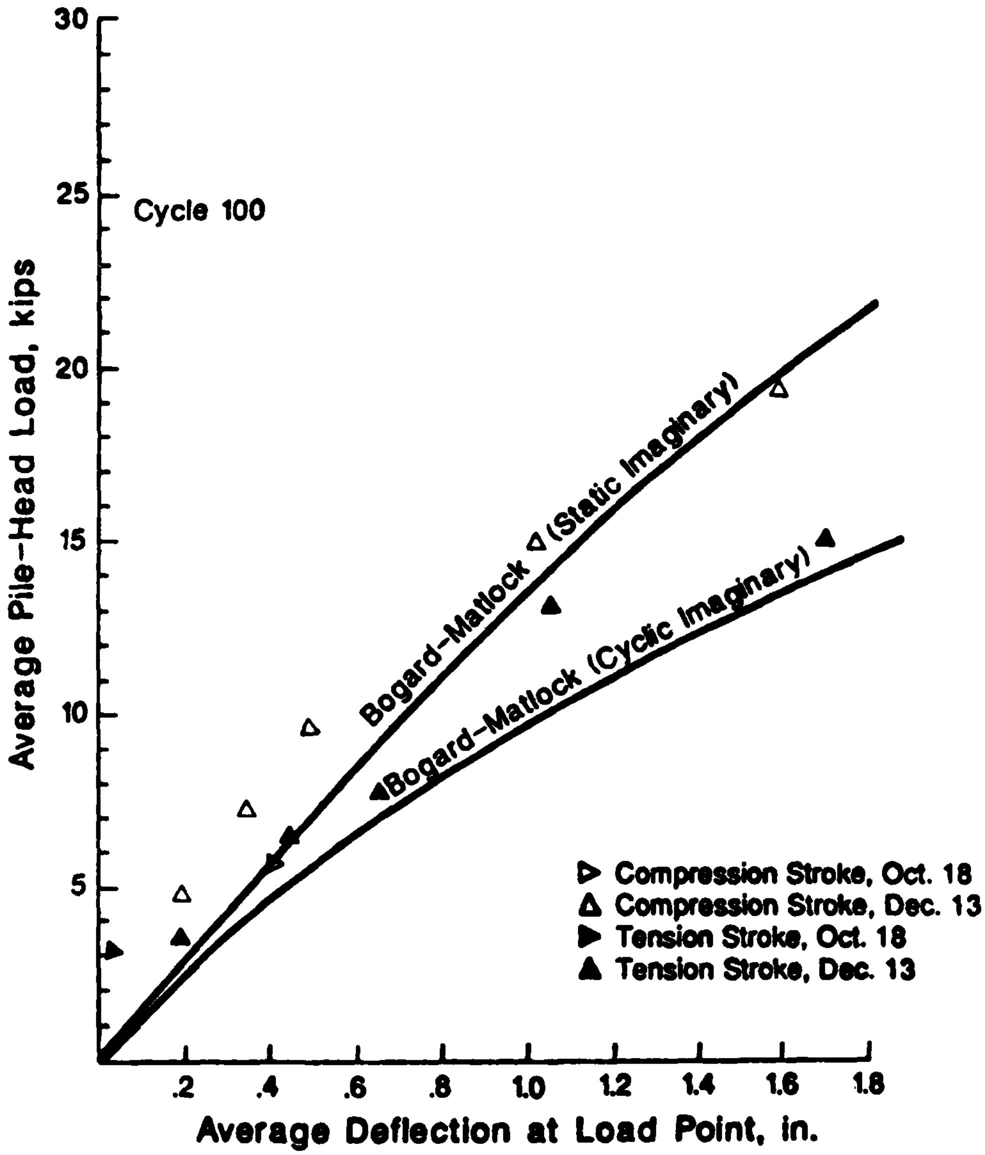


Fig. 6.23. Comparison of measured deflections with cyclic deflections computed by the Bogard-Matlock method.

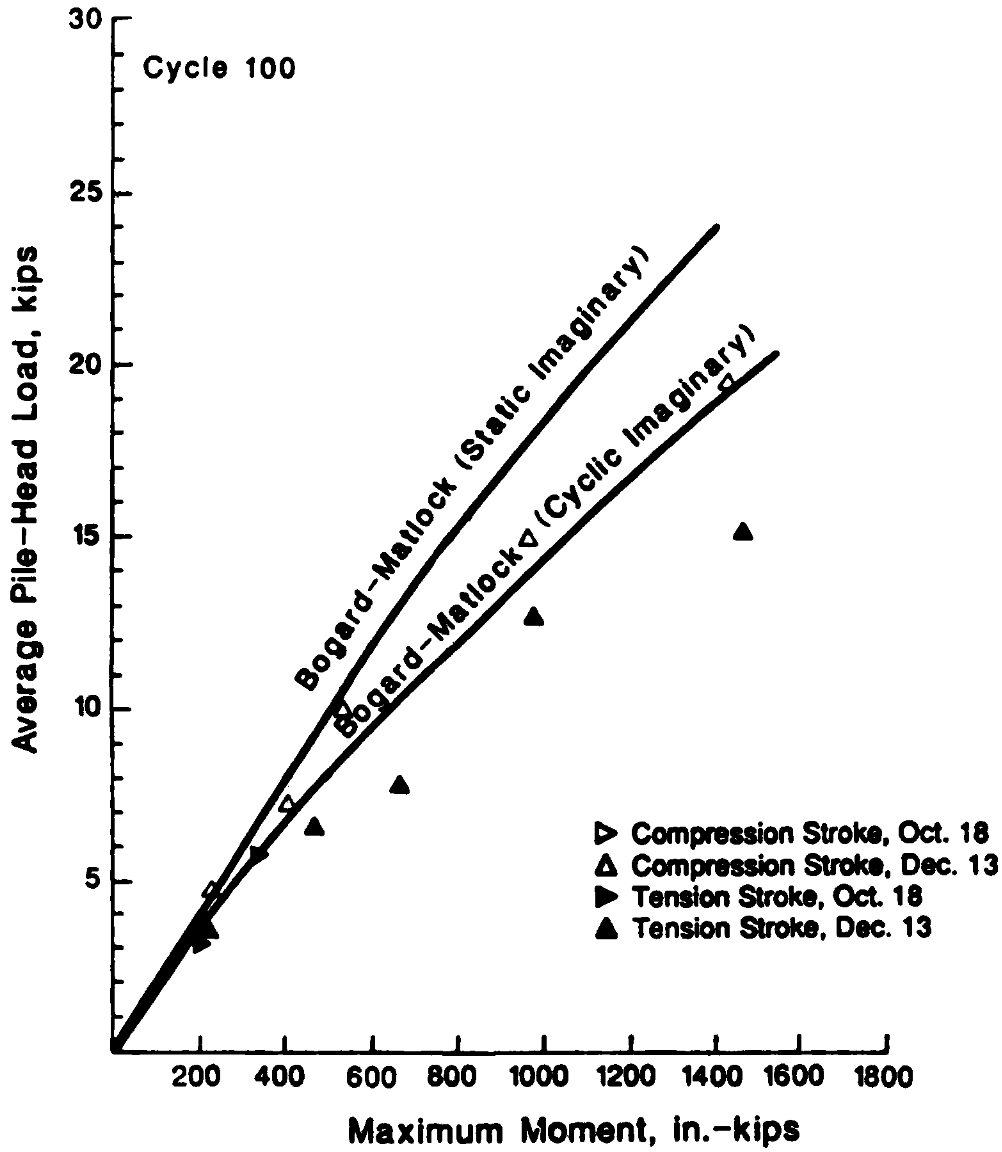


Fig. 6.24. Comparison of measured maximum moments with cyclic maximum moments computed by the Bogard-Matlock method.

up to 60%. When the cyclic procedure is used to generate the modified p-y curves for the imaginary pile the agreement between calculated and measured maximum moments is good.

**Summary**

For static loading the Bogard-Matlock method overpredicted measured deflections and underpredicted measured maximum moments. For cyclic loading two procedures can be used to generate modified p-y curves for the imaginary pile. When the static procedure is used, the Bogard-Matlock method overpredicts deflections for low load levels and underpredicts maximum moments for all load levels. When the cyclic procedure is used, the Bogard-Matlock method overpredicts deflections, but shows good agreement with measured maximum moments. The Bogard-Matlock method assumes a uniform distribution of load to the individual piles. This does not agree with the measured group behavior.

## CONCLUDING COMMENT

The results of comparisons between the measured behavior of the group of piles and the behavior calculated by several analytical procedures have been presented in this chapter. These results are summarized in Table 6.1. Although several of the methods were successful in

TABLE 6.1. SUMMARY OF RESULTS OF COMPARISONS OF CALCULATED AND MEASURED GROUP BEHAVIOR.

| Method | Static | | | Cyclic | | |
|---|---|---|---|---|---|---|
| | Deflection | Maximum Moment | Load Distribution | Deflection | Maximum Moment | Load Distribution |
| DEFPIG No Local Yield | Low load levels: good agreement high load levels: overprediction | -- | Too uniform | -- | -- | -- |
| DEFPIG With Local Yield | Good agreement | -- | Too uniform | -- | -- | -- |
| Focht-Koch | Good agreement | Low load levels: good agreement high load levles: underprediction | Too uniform | Good agreement | Low load levels: good agreement high load levels: underprediction | Too uniform |
| Single-Pile | Overprediction | Low load levels: good agreement high load levles: underprediction | Too uniform | Overprediction | Good agreement | Too uniform |
| Bogard-Matlock (static imaginary) | Overprediction | Underprediction | Too uniform | Low load levels: overprediction high load levels: good agreement | Underprediction | Too uniform |
| Bogard-Matlock (cyclic imaginary) | -- | -- | -- | Overprediction | Good agreement | Too uniform |

predicting either deflections or maximum moments, no method was able to make correct predictions of deflections, maximum moments, and the distribution of load to the piles. This fact suggests that areas of agreement between measured and calculated results could be due to coincidence rather than a correct modeling of the mechanics of group behavior.

# CHAPTER 7

## A PROCEDURE FOR CALCULATING THE BEHAVIOR OF THE TESTED GROUP OF PILES

### INTRODUCTION

Presented in this chapter is a procedure for calculating the behavior of a group of closely-spaced piles under lateral loadings. The procedure is based on the results of the testing of the group considered in this report. The procedure allows the calculation of the deflection of the group, the maximum bending moment, and the distribution of load to the individual piles. The procedure is intended to be one step toward a better understanding of the behavior of groups of piles in sand. Design professionals choosing to use this procedure should carefully consider differences between their design problem and the details of the test considered in this report.

### IMPORTANT ASPECTS OF GROUP BEHAVIOR

Some aspects of the behavior of the group noted from the results of the load test were not taken into account by any of the analytical methods examined in Chapter 6. These aspects are important to the behavior of

the group, and will be taken into account in the proposed procedure.

It should be noted that the distribution of load to the individual piles in the group is not uniform. In both the static and cyclic cases, the leading row carried the largest share of the load, and the trailing row carried the smallest share of the load. No clear pattern could be detected in the distribution of load to the piles in an individual row. In the proposed procedure the load will be distributed equally among the piles in an individual row, but each row will carry a different portion of the load.

Also, it should be noted from the measured p-y curves shown in Chapter 5 for the piles in the group that the ultimate soil resistance is different for different rows. The ultimate soil resistance for piles in the leading row is larger than the ultimate resistance for the middle row which is in turn larger than that for the trailing row. This suggests that the p-y curves for the piles in the group should be modified by a p-factor as proposed by Brown and Reese (1985) rather than by a y-factor as used by Focht and Koch (1973), and that different p-factors should be used for piles in different rows.

## DEMONSTRATION OF THE PROPOSED PROCEDURE

The proposed procedure is used here to calculate a load-vs.-deflection curve, a load vs. maximum moment curve, and the distribution of load to the individual piles for both static and cyclic loading of the group used in the load test. The calculated results are compared with the measured results of the load tests.

### Static Case

Separate sets of p-y curves are first generated for each row of piles. These curves are generated by multiplying the soil-resistance values of the p-y curves for an isolated pile by a factor, $p_{mult}$. For the case considered here the p-y curves for the isolated pile were generated using the modified Reese, Cox, and Koop procedures for static loading described in Chapter 5. The factors applied to the soil-resistance values were 0.8, 0.4, and 0.2, for the leading row, middle row and trailing row respectively. These factors were determined by trial. That they are appropriate is demonstrated by the curves for load vs. deflection and for load vs. maximum moment shown in Figs. 7.1 through 7.6. The curves were calculated using the p-y curves generated with the soil resistance factors and are shown with points representing measured deflections and maximum moments for the individual piles.

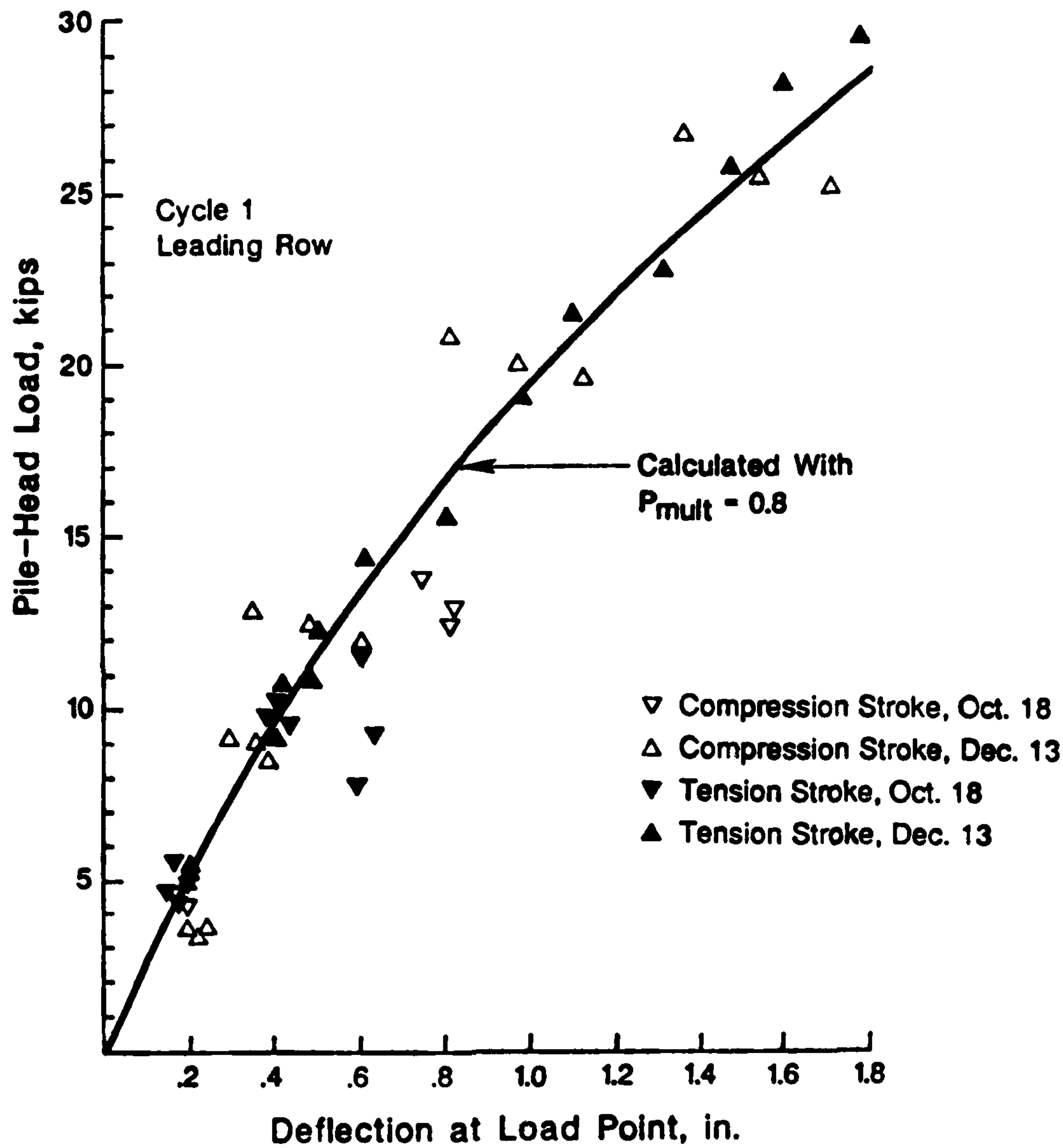


Fig. 7.1. Comparison of deflections for the static case with the computed deflection for the leading row of piles.

AD-A194 216 A LATERIAL-LOAD TEST OF A FULL-SCALE PILE GROUP IN SAND 3/4
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UNCLASSIFIED DACW39-83-C-0061 F/G 13/13 NL


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0

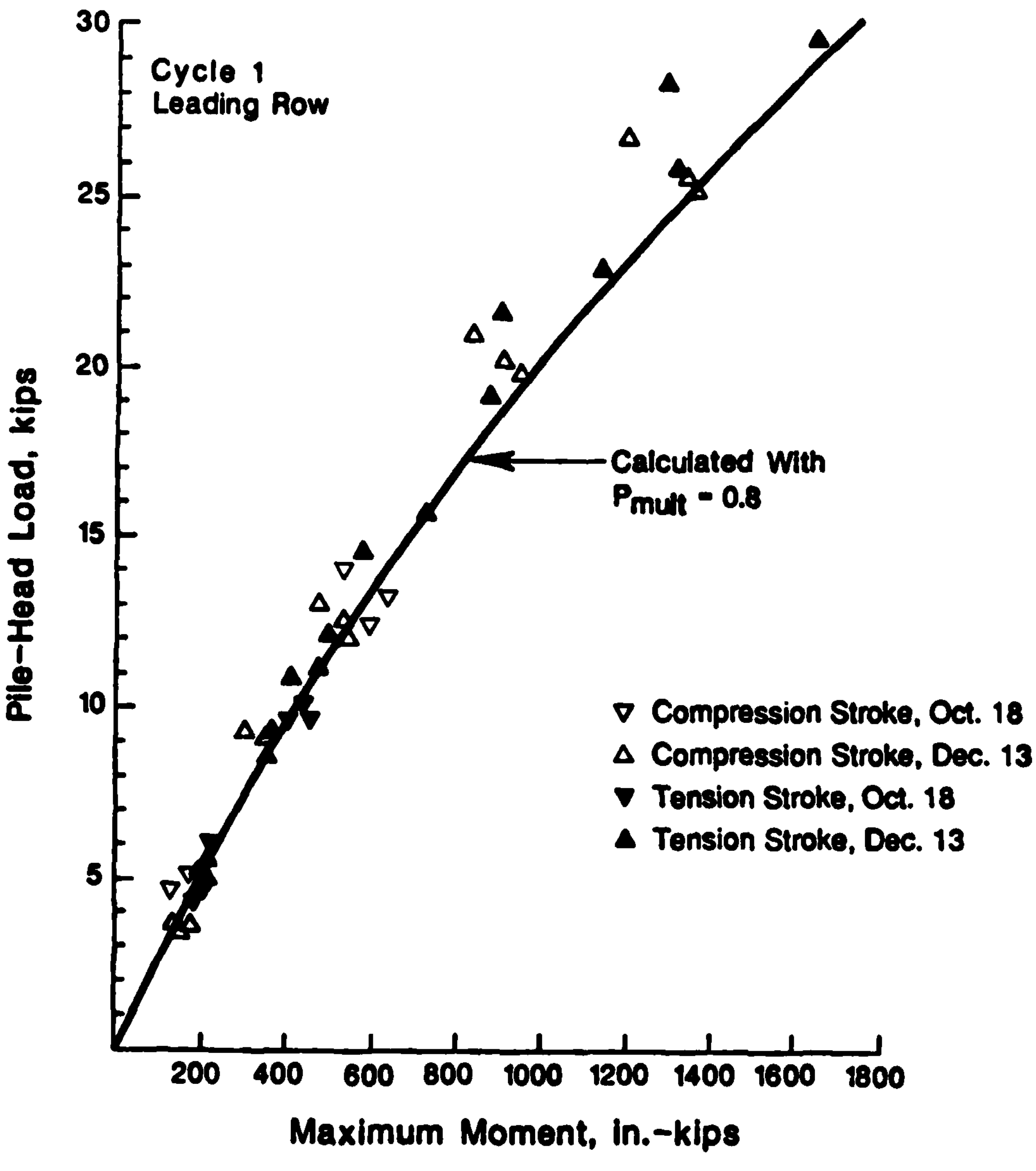


Fig. 7.2. Comparison of measured maximum moments for the static case with the computed maximum moments for the leading row of piles.

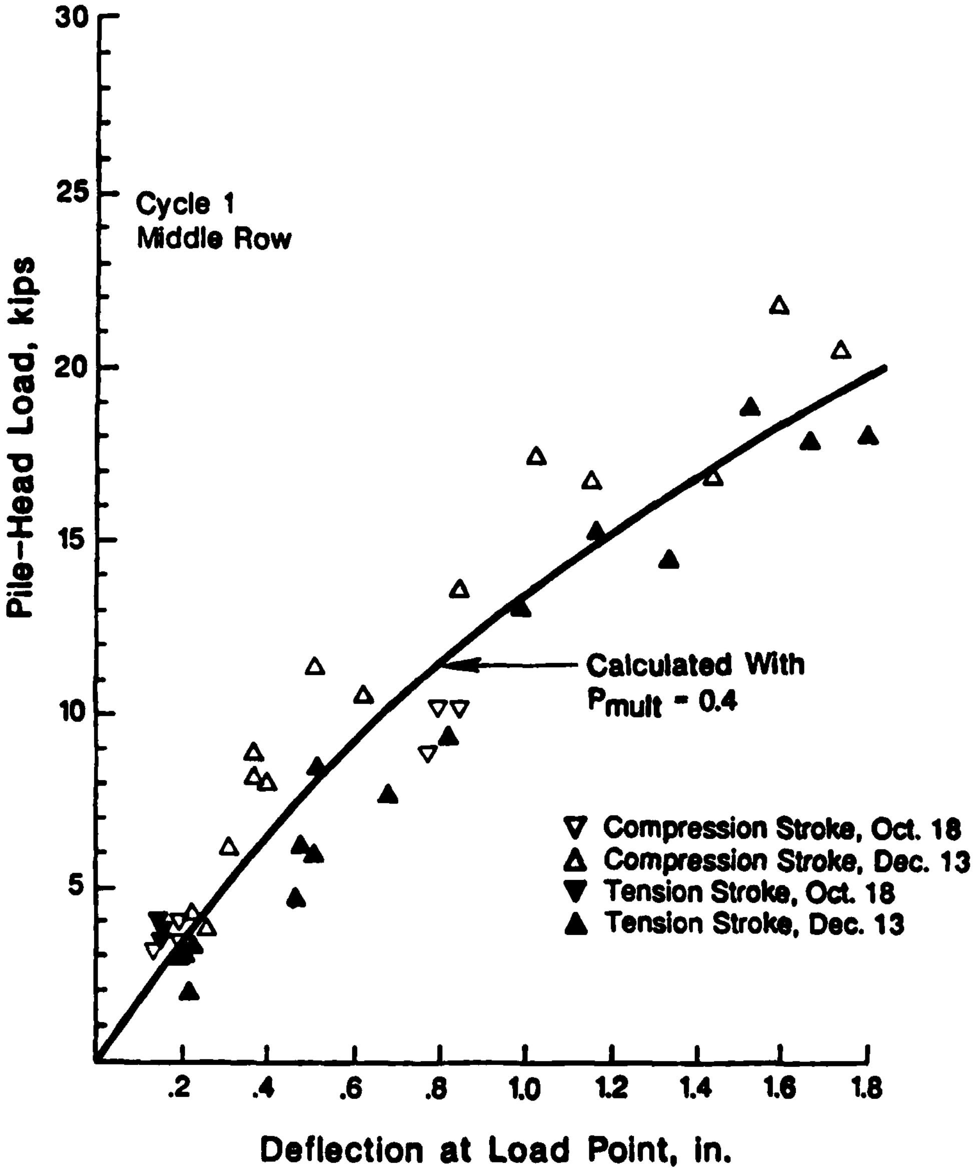


Fig. 7.3. Comparison of measured deflections for the static case with the computed deflections for the middle row of piles.

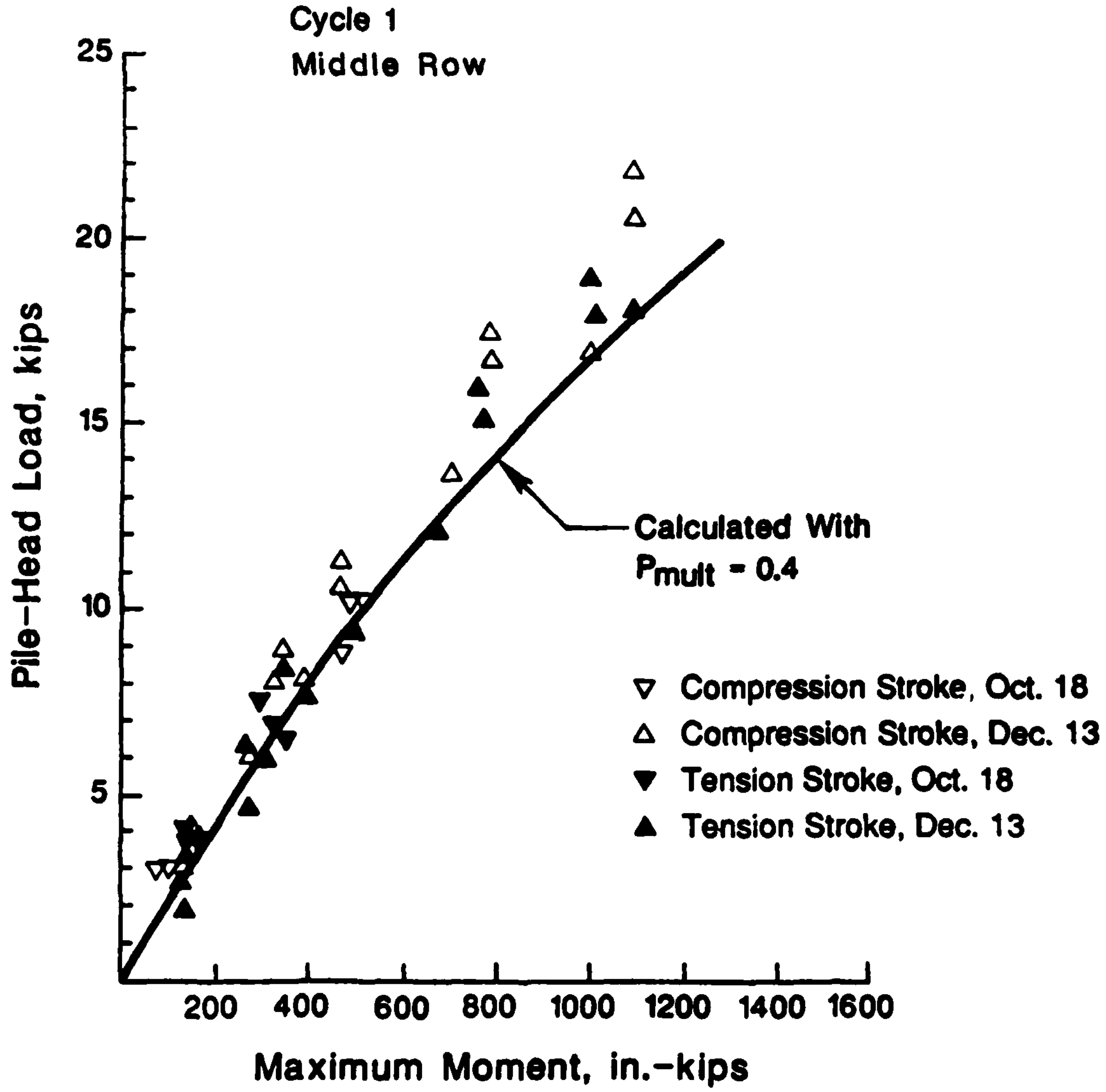


Fig. 7.4. Comparison of measured maximum moments for the static case with the computed maximum moments for the middle row of piles.

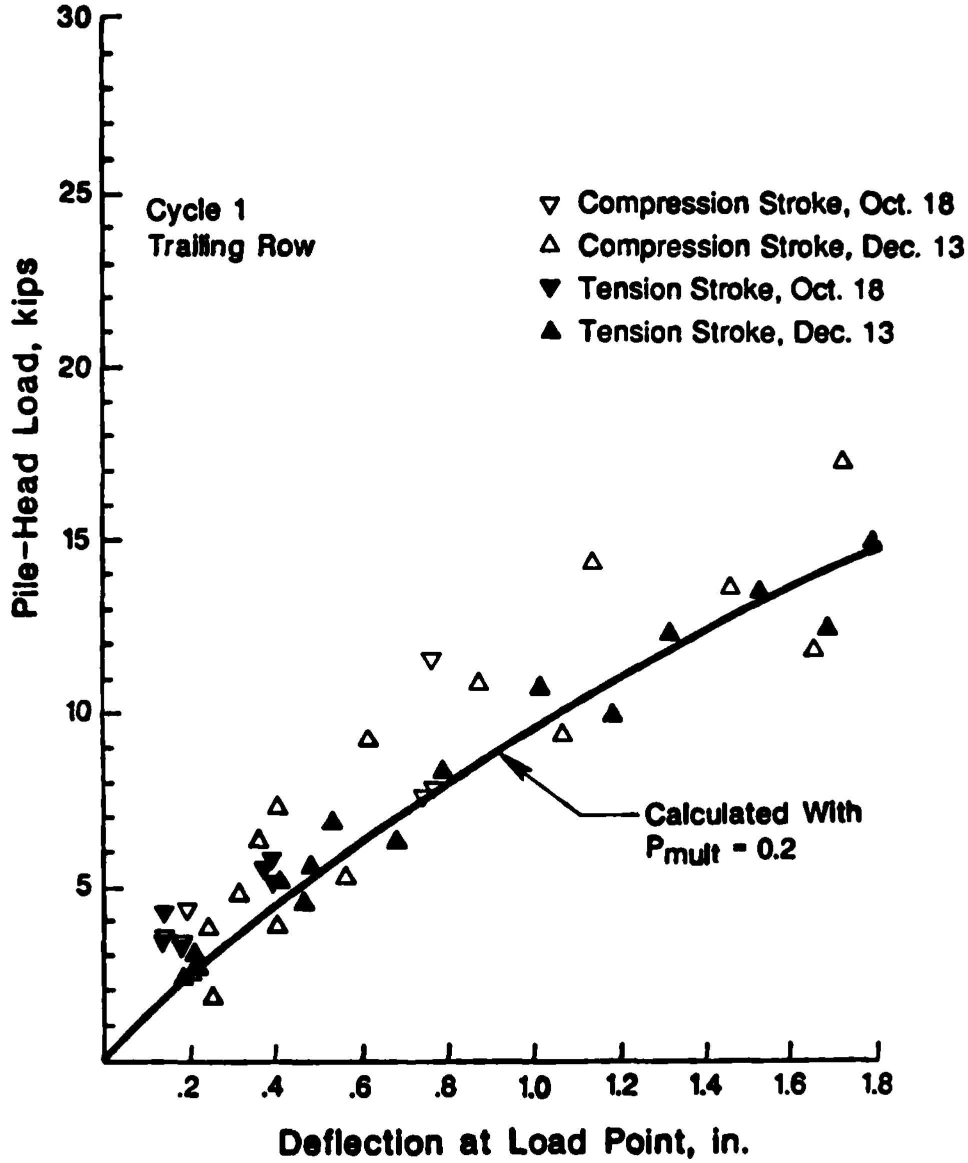


Fig. 7.5. Comparison of measured deflections for the static case with the computed deflections for the trailing row of piles.

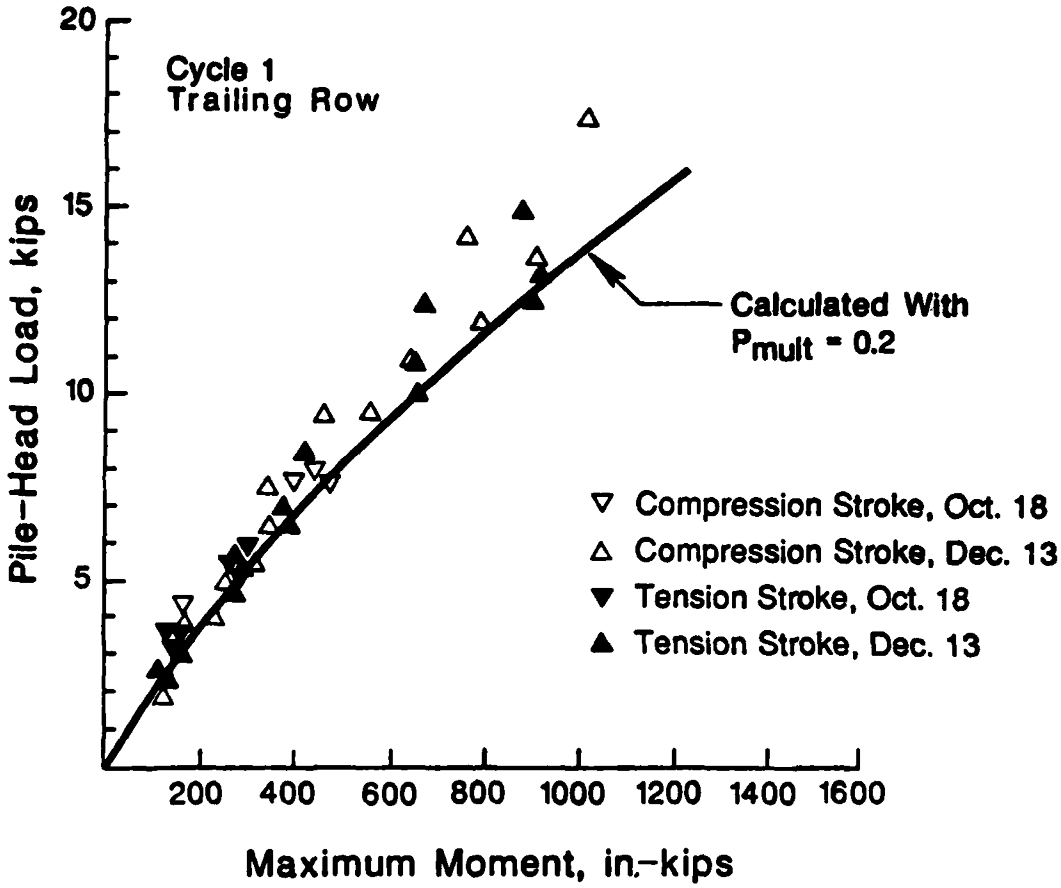


Fig. 7.6. Comparison of measured maximum moments for the static case with the computed maximum moments for the trailing row of piles with.

Using the load deflection curves for the piles in the individual rows shown in Figs. 7.1, 7.3, and 7.5, an average pile-head load vs. deflection curve is constructed by averaging the pile head loads for a given deflection. This curve is shown in Fig. 7.7 and represents the load vs. deflection curve for the group as a whole. The curve is plotted again in Fig. 7.8 along with measured deflections of the group.

The curve of maximum moment vs. load for the group is constructed by first using Fig. 7.7 to determine the maximum load on an individual pile for a given average load per pile for the group. The maximum moment for the average load is then found from the moment corresponding to the maximum load in Fig. 7.2. The curve for maximum moment vs. load for the group constructed in this manner is shown in Fig. 7.9 along with points representing the measured maximum moments.

The distribution of load to the piles in the group is easily determined from Fig. 7.7. A load distribution determined in this manner is compared with a typical measured load distribution in Fig. 7.10.

**Cyclic Case**

The proposed design procedure is the same for cyclic loading. First, p-y curves are generated for an isolated pile using the modified Reese, Cox and Koop

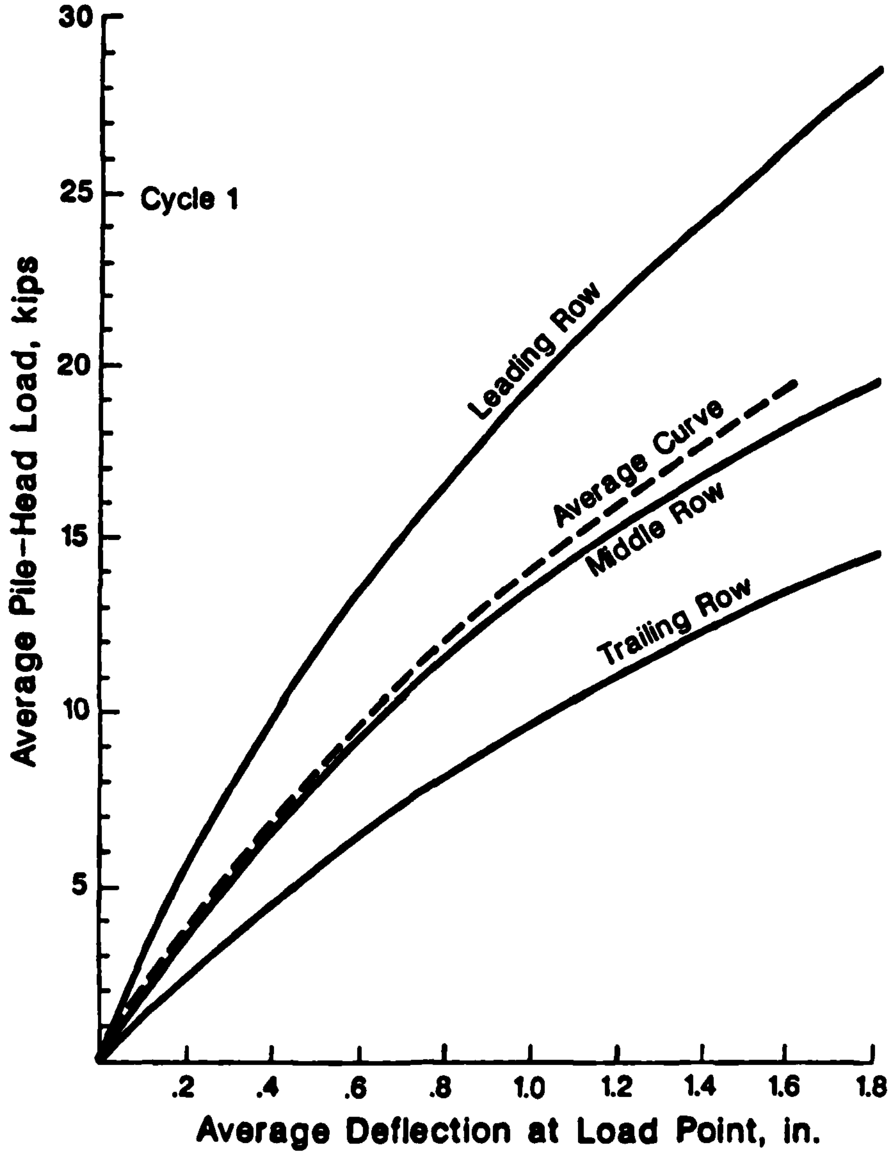


Fig. 7.7. Construction for the static case of an average curve for the pile group giving load versus deflection of the pile load..

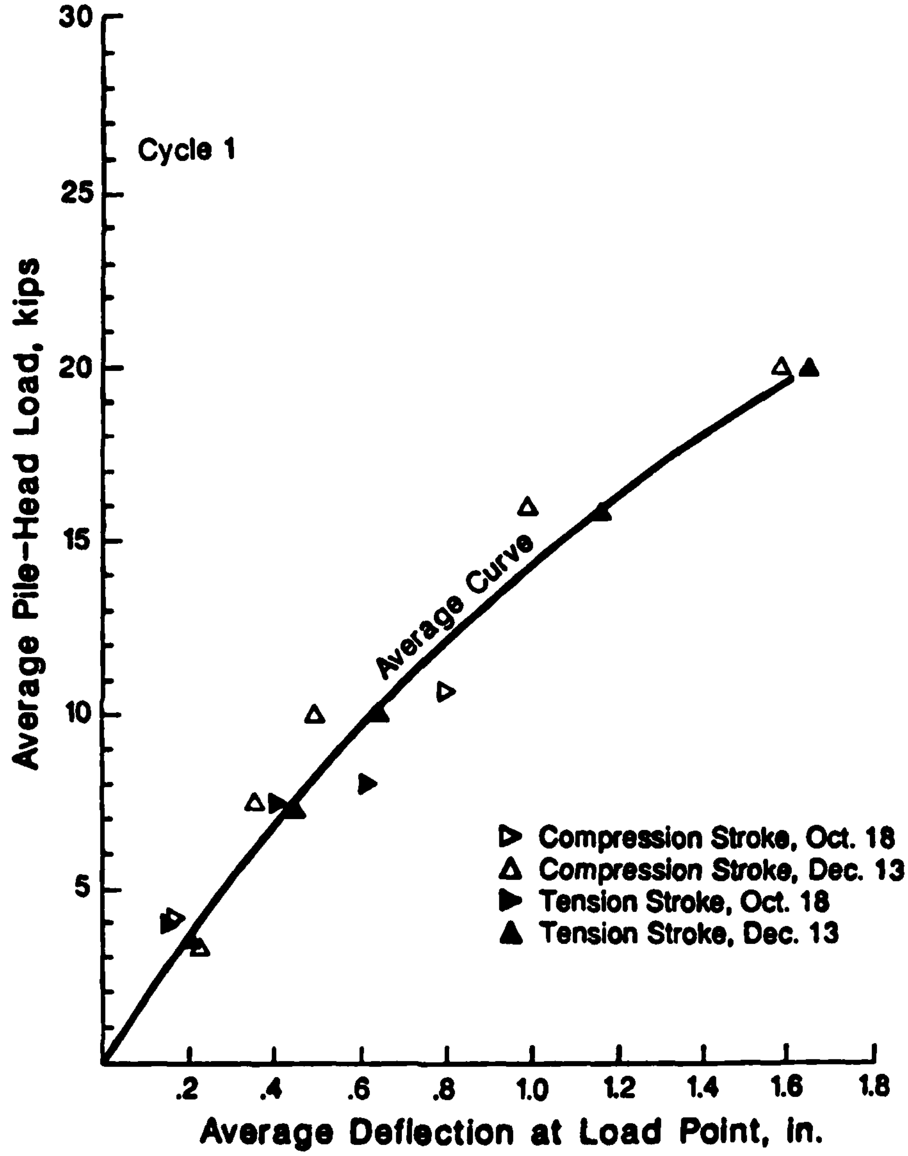


Fig. 7.8. Comparison of measured deflections for the static with the computed deflections by the proposed procedure.

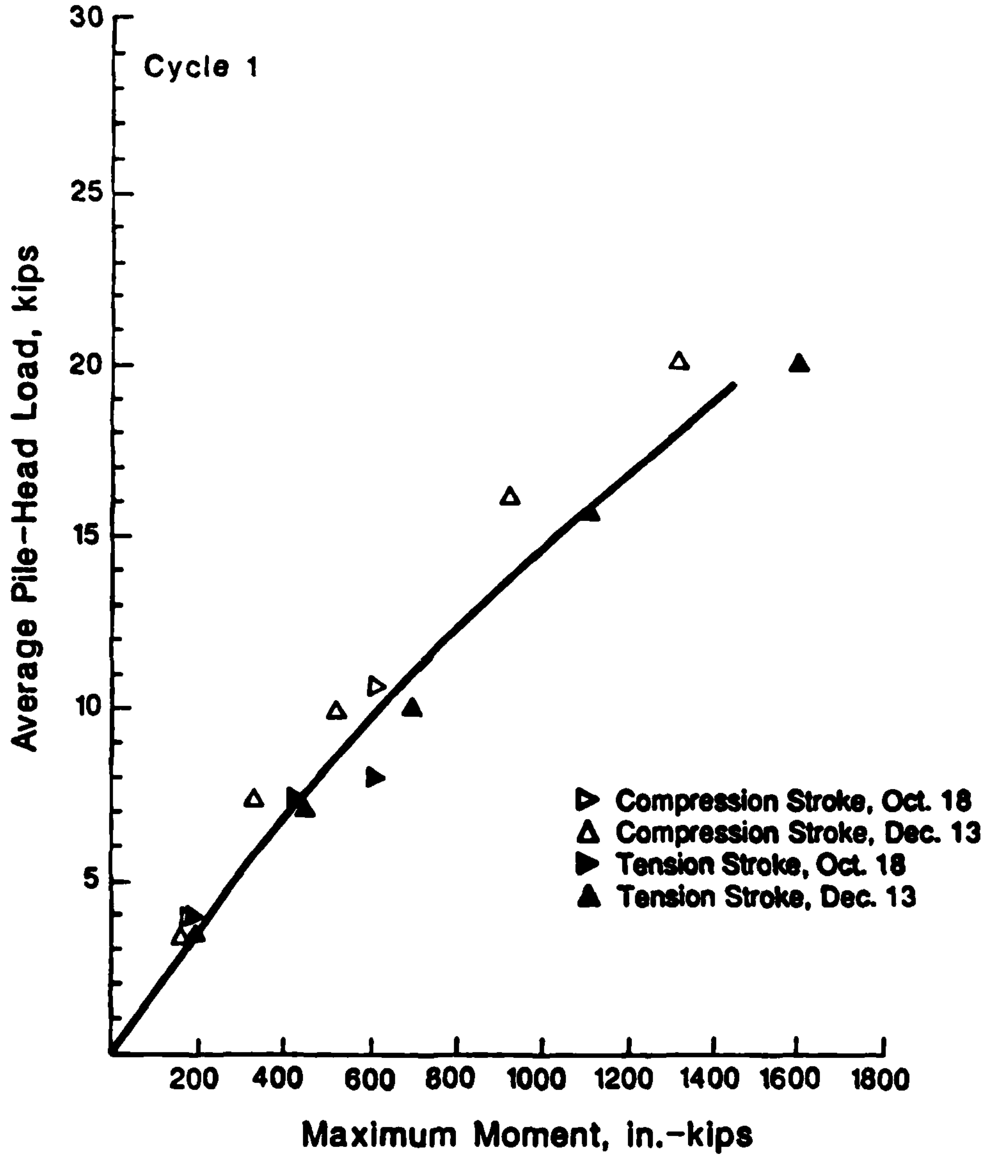


Fig. 7.9. Comparison of measured maximum moments for the static case with maximum moments computed by the proposed procedure.

Measured Load Distribution
Compression Stroke Cycle 1
Load = 66 $^k$(7.34 $^k$/ pile)

| | | | | Portion of Load Taken by Each Row |
|---|---|---|---|---|
| Leading Row | 1.16 | 1.25 | 1.26 | 41% |
| Middle Row | 1.10 | 1.21 | 0.83 | 35% |
| Trailing Row | 1.01 | 0.53 | 0.66 | 24% |

Load Distribution Calculated by
Proposed Design Procedure
Load = 72 $^k$(8 $^k$/pile ) Static Load

| | | | | Portion of Load Taken by Each Row |
|---|---|---|---|---|
| Leading Row | 1.31 | 1.31 | 1.31 | 44% |
| Middle Row | 1.01 | 1.01 | 1.01 | 34% |
| Trailing Row | 0.68 | 0.68 | 0.68 | 23% |

Values shown represent the pile-head load divided by the average pile-head load.

Fig. 7.10. Comparison of the measured load distribtion for the static case for the load distribution computed by the proposed procedure.

procedure for cyclic loading described in Chapter 5. Factors of 0.8, 0.4, and 0.2, for the leading, middle and trailing rows, respectively, were applied to the soil resistance values. The factored p-y curves were then used to calculate the curves for load vs. deflection and for load vs. maximum moment shown in Fig. 7.11 through 7.16.

The average-load-vs.-deflection curve for the group of piles was constructed using the same procedure as used for static loading. This curve is shown in Fig. 7.17 and again in Fig. 7.18 with points representing measured deflections of the group.

The load-vs.-maximum moment curve for cyclic loading is constructed using the same procedure as used for static loading. The curve is shown in Fig. 7.19 along with points representing measured maximum moments in the group.

The distribution of load to the individual piles in the group is easily determined from Fig. 7.17. The distribution of load determined in this manner is compared with a typical measured load distribution in Fig. 7.20.

**CONCLUDING COMMENT**

The proposed design procedure was successful in calculating the behavior of the group of piles used in the load test described in this report. This is not

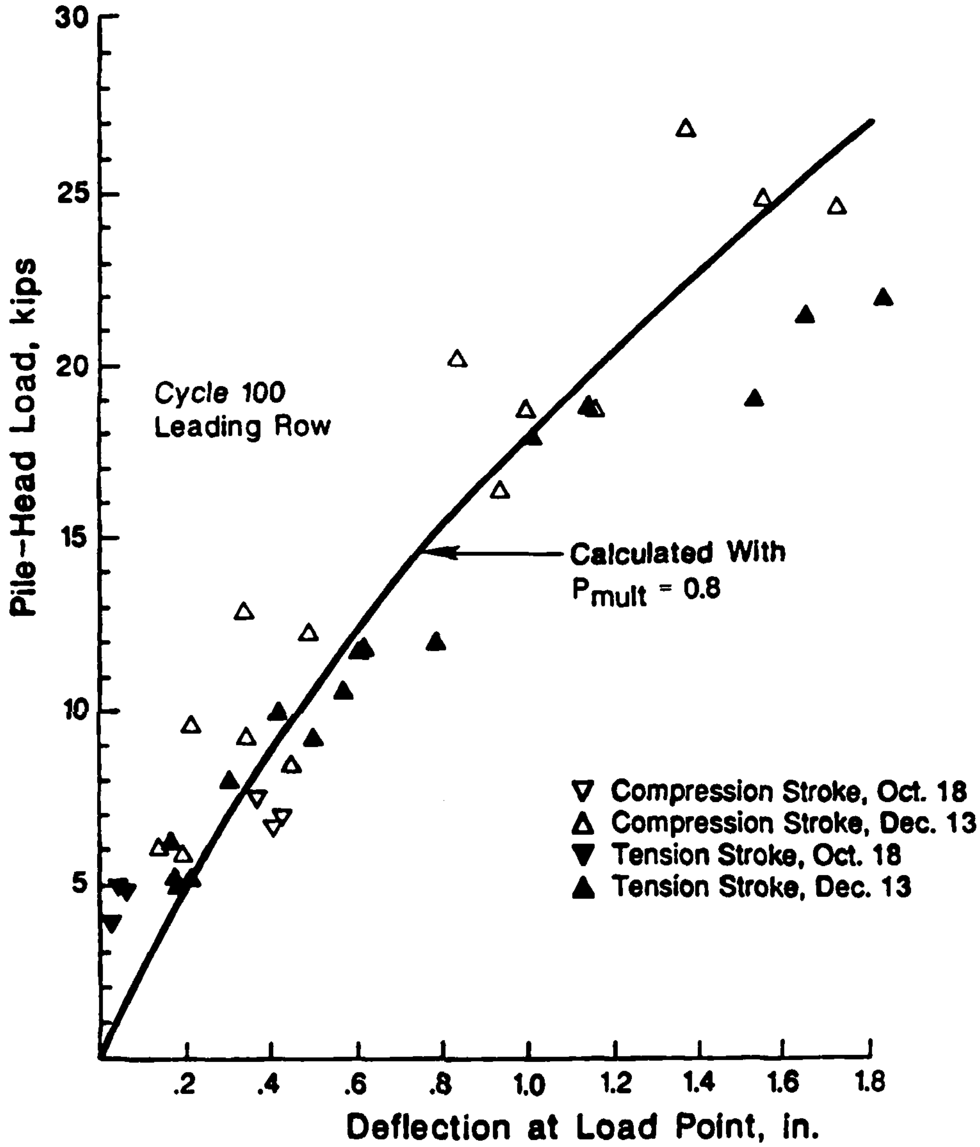


Fig. 7.11. Comparison of measured deflections for the cyclic case with the computed deflections for the leading row of piles.

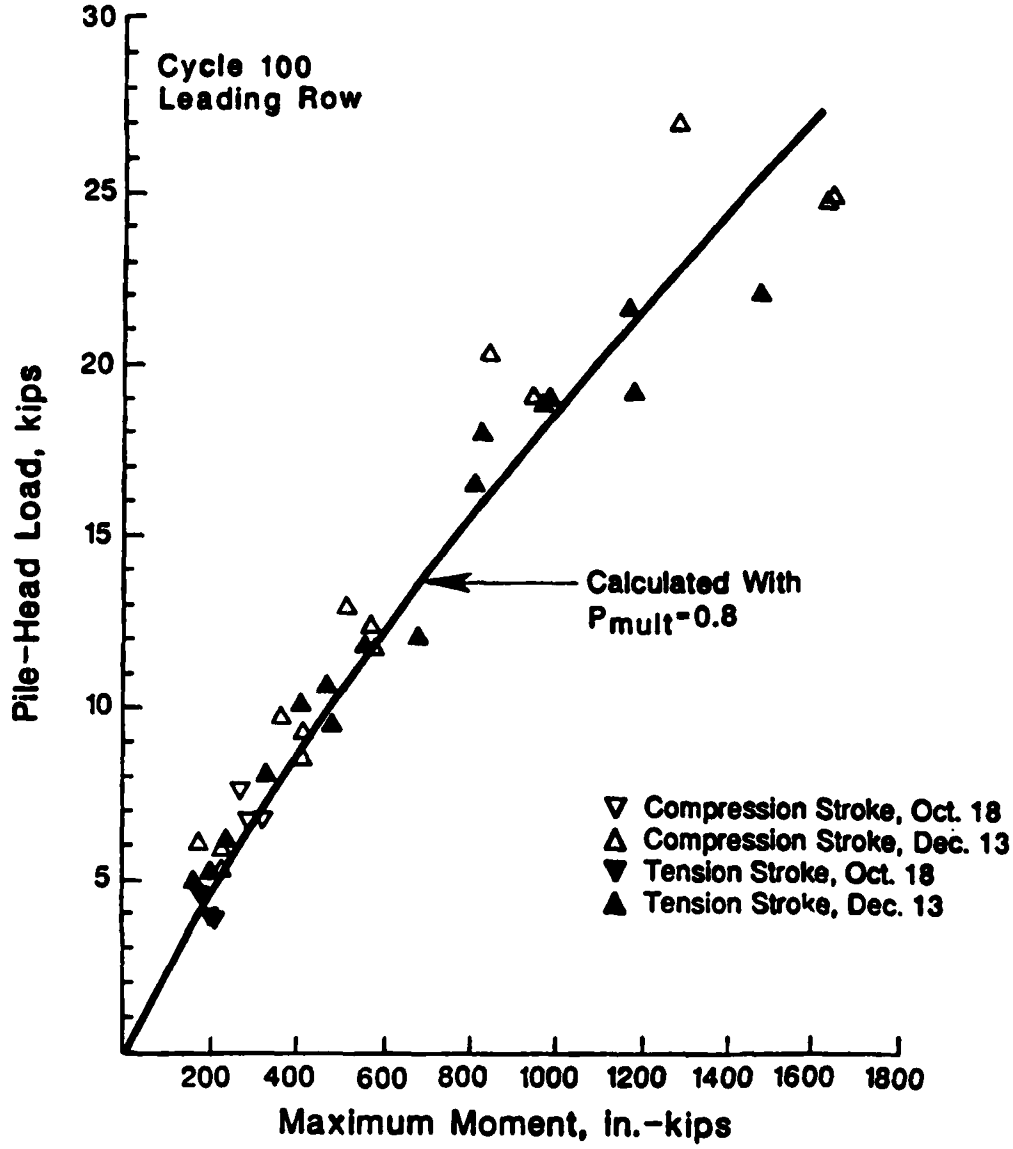


Fig. 7.12. Comparison of measured maximum moments for the cyclic case with the computed maximum moments for the leading row of piles.

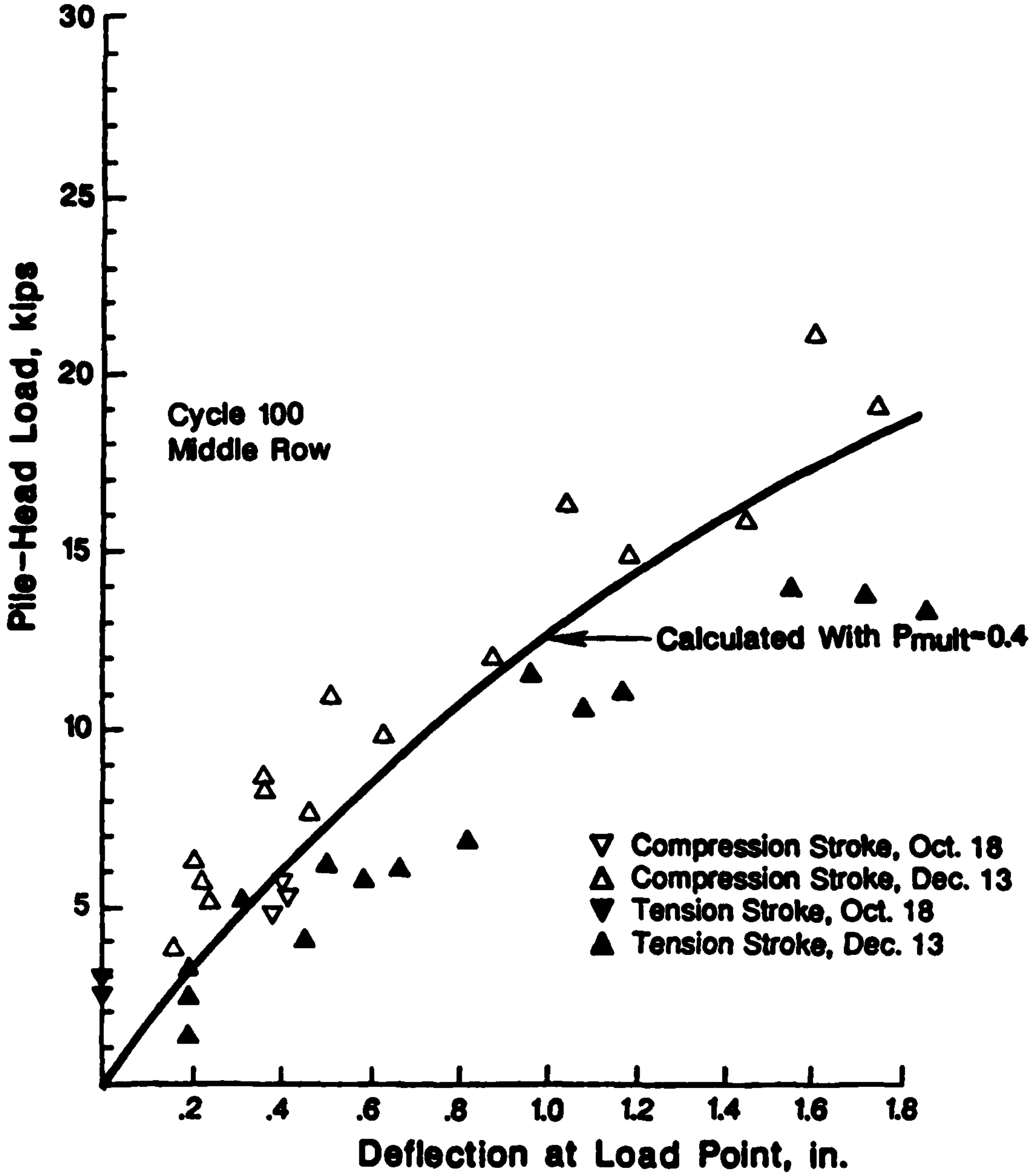


Fig. 7.13. Comparison of measured deflections for the cyclic case with computed deflections for the middle row of piles.

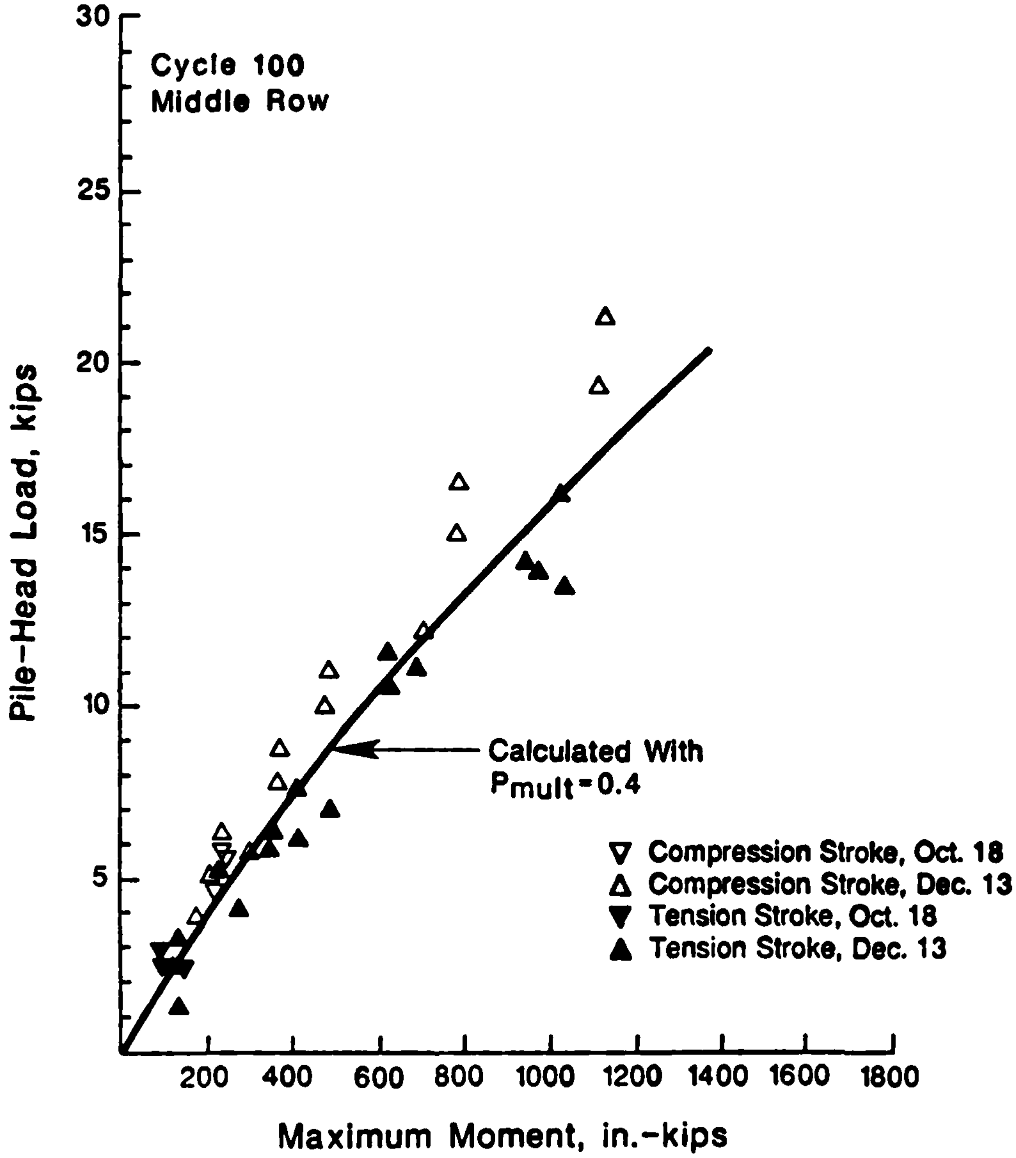


Fig. 7.14. Comparison of measured maximum moments for the cyclic case with the computed maximum moments for the middle row of piles.

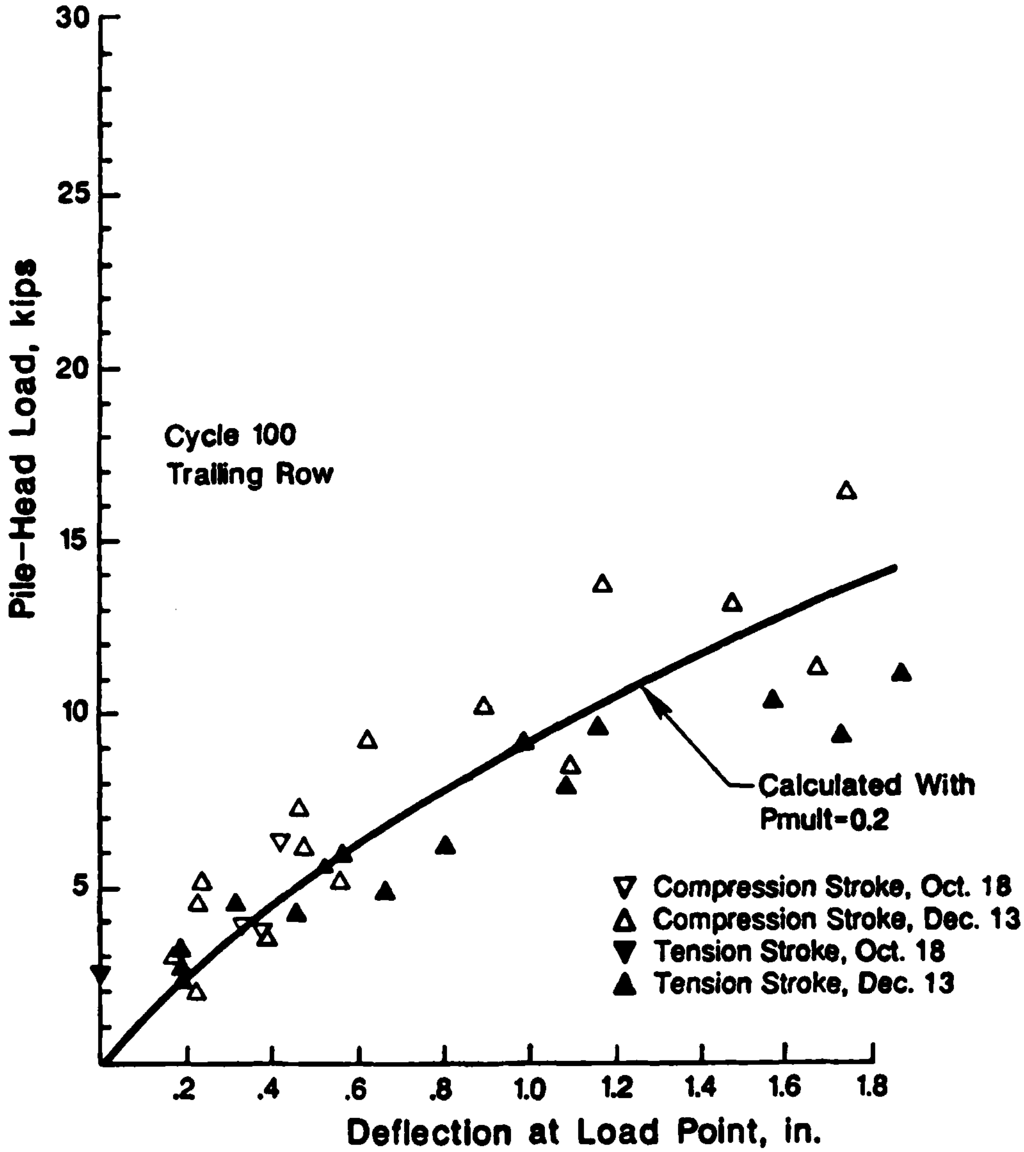


Fig. 7.15. Comparison of measured deflections for the cyclic case with the computed deflections for the trailing row of piles.

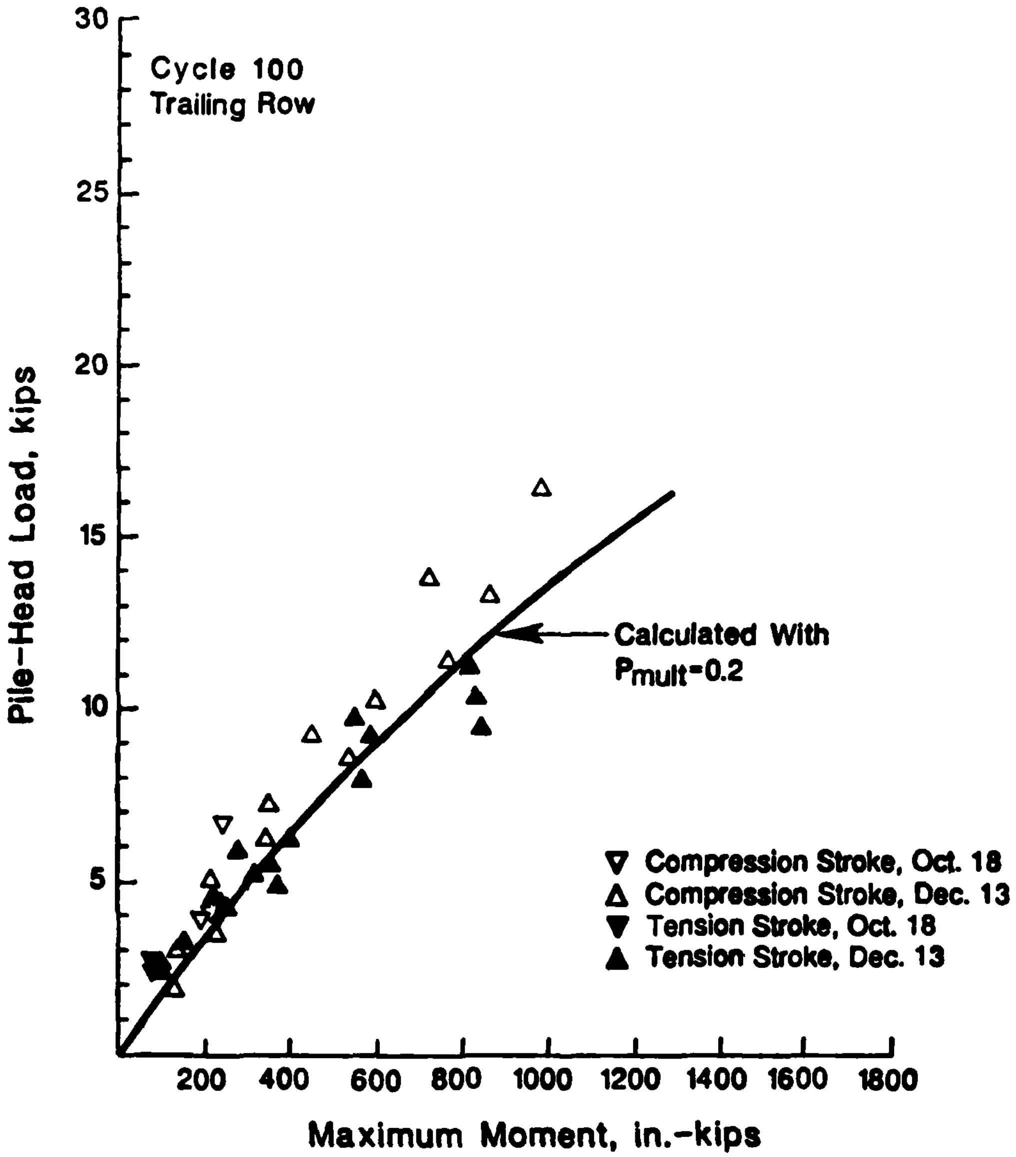


Fig. 7.16. Comparison of measured maximum moments for the cyclic case with the computed maximum moments for the trailing row of piles.

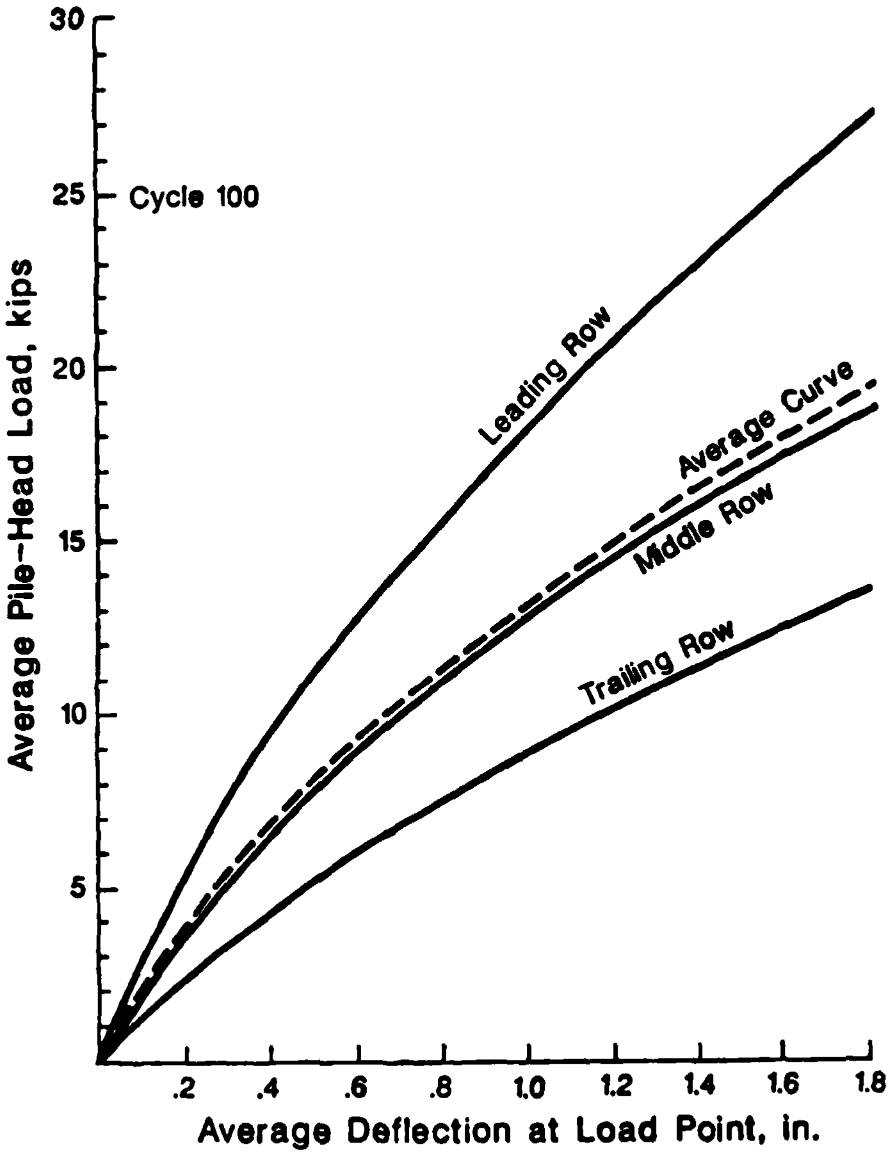


Fig. 7.17. Construction for the cyclic case of an average curve for the pile group pile-head load vs. deflection .

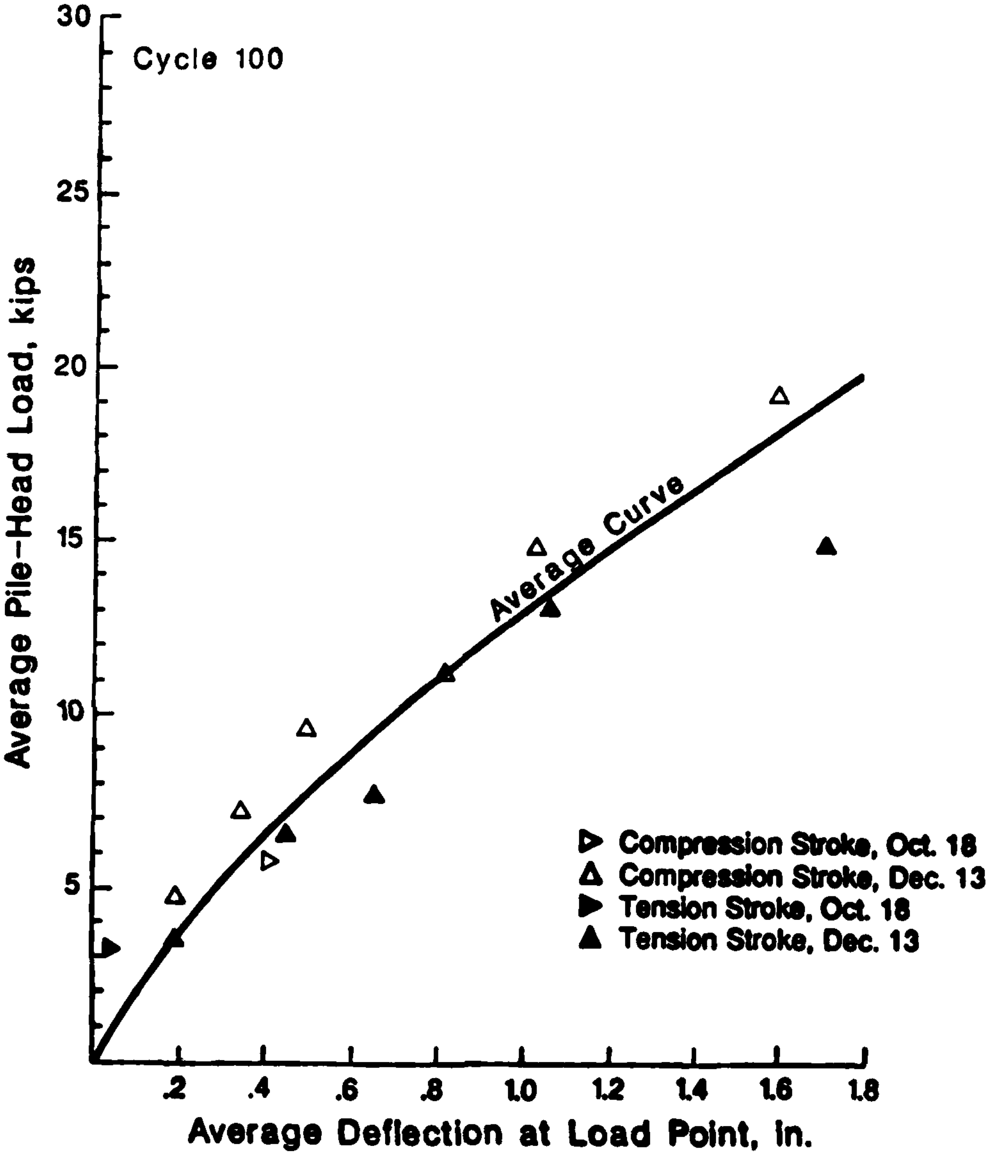


Fig. 7.18. Comparison of measured deflections with cyclic deflections computed by the proposed procedure.

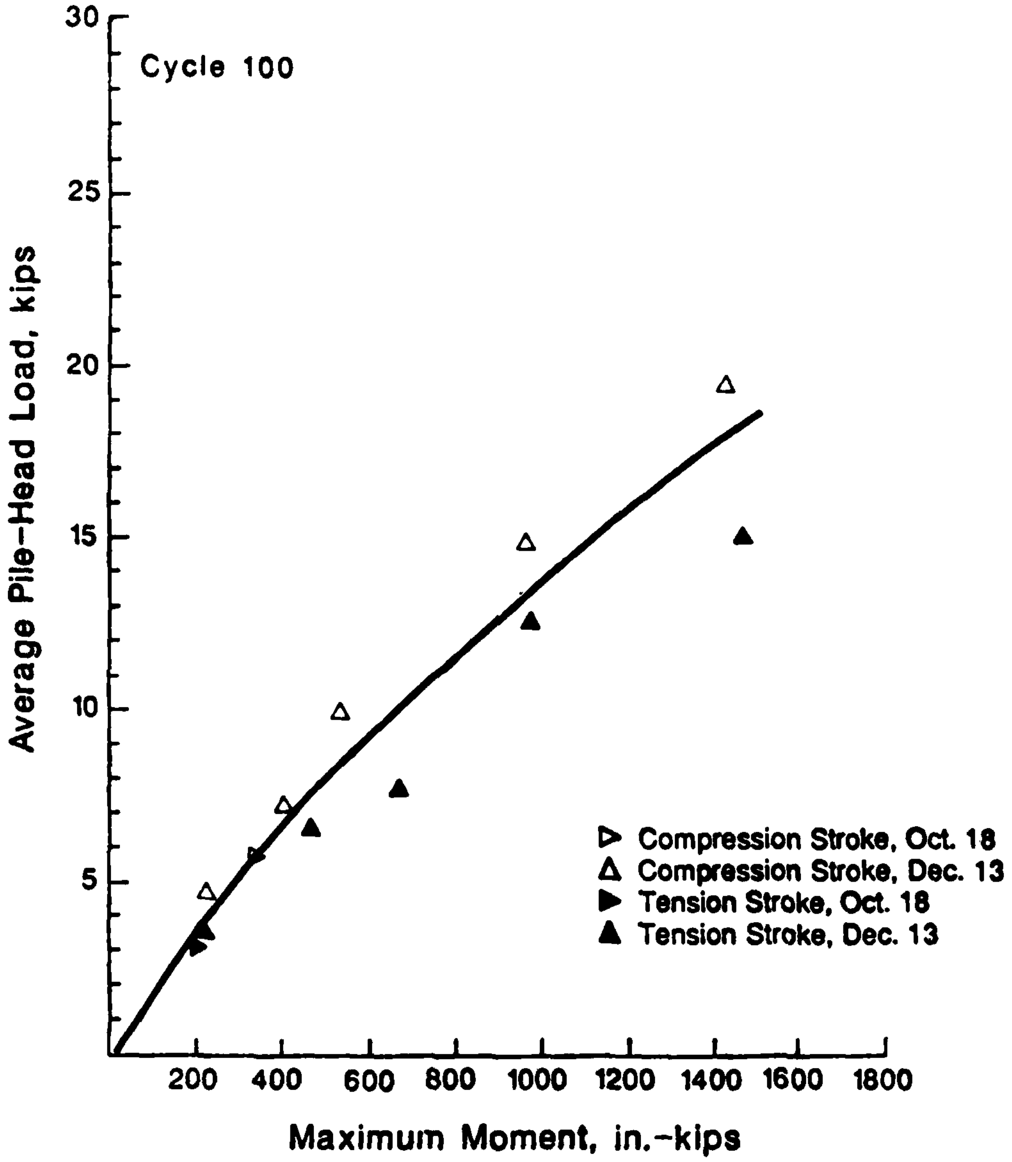


Fig. 7.19. Comparison of measured maximum moments with cyclic maximum moments computed by the proposed procedure.

Measured Load Distribution
Compression Stroke Cycle 100
Load = $65^{k}$ ($7.20^{k}$/pile)

| | | | | Portion of Load Taken by Each Row |
|---|---|---|---|---|
| Leading Row | 1.17 | 1.78 | 1.34 | 42 % |
| Middle Row | 1.08 | 1.22 | 0.81 | 35 % |
| Trailing Row | 1.00 | 0.48 | 0.62 | 23 % |

Load Distribution Calculated by
Proposed Design Procedure
Load = $72^{k}$ ($8.00^{k}$/pile) Cyclic Load

| | | | | Portion of Load Taken by Each Row |
|---|---|---|---|---|
| Leading Row | 1.38 | 1.38 | 1.38 | 46 % |
| Middle Row | 0.97 | 0.97 | 0.97 | 32 % |
| Trailing Row | 0.65 | 0.65 | 0.65 | 22 % |

Values shown represent the pile-head load divided by the average pile-head load.

Fig. 7.20. Comparison of measured load distribution for the cyclic case with load distribution computed by the proposed procedure.

surprising since the procedure was based upon the load test. The critical step in the procedure is the determination of the factors applied to the soil resistance values of the p-y curves for an isolated pile. In this case the factors were determined by trial and error. For other cases, the factors are expected to vary with pile spacing, pile stiffness, soil stiffness, and soil strength. Unfortunately, the data obtained from this group of piles provide limited insight into what factors should be chosen for a different group of piles in a different sand. Data from other pile groups are necessary if this procedure is to be developed into a design method of broad applicability.

# CHAPTER 8

# CONCLUSIONS

This report has described load tests performed in sand on a single pile and a group of closely-spaced piles. Both the single pile and the group of piles were well-instrumented. The results of measurements taken are presented in Appendices A, B, and C, and are summarized in Chapter 5. The following conclusions can be drawn from the data:

1. The response of the single pile to lateral load is stiffer than the response of the average pile in the group.

2. For both the single pile and the piles in the group, the response of the piles to static loading is stiffer than the response to cyclic loading.

3. The distribution of load to the piles in the group is not uniform. The leading row takes a larger portion of the load than the middle row which in turn takes a larger portion than the trailing row.

4. The ultimate soil resistance for the leading row of piles is larger than the ultimate soil resistance for the middle row which in turn is larger than that for the trailing row.

The results of comparisons between the measured behavior of the pile group and the behavior computed by several analytical procedures are presented in Chapter 6. Although several of the methods were successful in

predicting either deflections or maximum moments, no method was able to predict both correctly. None of the methods took into account the non-uniform distribution of load distribution that was observed in the load test, or the difference in ultimate soil resistance observed for piles in different rows.

A procedure for calculating the behavior of the tested group of piles was presented in Chapter 7. The procedure accounts for the non-uniform load distribution and the difference in ultimate soil resistance for piles in different rows. The procedure was successful in calculating the behavior of the group of piles in the load test.

The information presented in this report is judged to be of value to engineering professionals engaged in the design of groups of closely-spaced piles in sand. The computation procedure presented in Chapter 7 may be of limited value at present because of the use of empirical factors applied to the ultimate soil resistance for an isolated pile. These factors are expected to vary with pile spacing, pile stiffness, soil stiffness, and soil strength. Further research, including additional load testing, is probably required over a range of the controlling variables in order to develop sound procedures for predicting the behavior of pile groups in sand.

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## APPENDIX A

Results of the load test of the single pile,
October 11, 1984

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*******************************************************
*                 HOUSTON PILE STUDY                  *
* FIELD DATA FROM LATERAL LOAD TEST OF OCT 11, 1984  *
*******************************************************
```

LOAD NO. 1

UNITS - INCHES,KIPS,RADIANS

| DEPTH, INCHES | BENDING MOMENTS, INCH-KIPS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CYCLE 1001 | CYCLE 2001 | CYCLE 1005 | CYCLE 2005 | CYCLE 1010 | CYCLE 2010 | CYCLE 1020 | CYCLE 2020 |
| 0. | 46. | -34. | 35. | -29. | 35. | -33. | 40. | -23. |
| 6. | 69. | -49. | 52. | -43. | 52. | -49. | 59. | -34. |
| 12. | 92. | -67. | 69. | -58. | 69. | -65. | 77. | -46. |
| 24. | 129. | -58. | 99. | -84. | 99. | -93. | 107. | -68. |
| 36. | 151. | -119. | 119. | -102. | 119. | -109. | 126. | -84. |
| 48. | 150. | -125. | 122. | -109. | 122. | -115. | 127. | -93. |
| 60. | 131. | -116. | 112. | -103. | 112. | -108. | 116. | -90. |
| 72. | 104. | -96. | 92. | -89. | 93. | -93. | 96. | -81. |
| 84. | 75. | -72. | 68. | -70. | 76. | -73. | 72. | -66. |
| 96. | 49. | -47. | 46. | -48. | 47. | -51. | 49. | -47. |
| 108. | 29. | -29. | 27. | -31. | 28. | -34. | 29. | -32. |
| AT LOAD POINT: | | | | | | | | |
| DEFL | .13 | -.12 | .12 | -.11 | .12 | -.11 | .12 | -.10 |
| SLOPE | -.00202 | .00210 | -.00189 | .00173 | -.00184 | .00186 | -.00190 | .00163 |
| LOAD | 2.64 | -2.79 | 2.80 | -2.30 | 2.73 | -2.62 | 3.27 | -1.83 |

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* HOUSTON PILE STUDY *

* FIELD DATA FROM LATERAL LOAD TEST OF OCT 11, 1984 *

******************************************************

LOAD NO. 1

UNITS - INCHES,KIPS,RADIANS

| DEPTH, INCHES | BENDING MOMENTS, INCH-KIPS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CYCLE 1050 | CYCLE 2050 | CYCLE 1100 | CYCLE 2100 | CYCLE | CYCLE | CYCLE | CYCLE |
| 0. | 35. | -32. | 46. | -30. | | | | |
| 6. | 52. | -48. | 68. | -45. | | | | |
| 12. | 68. | -65. | 88. | -60. | | | | |
| 24. | 97. | -91. | 121. | -86. | | | | |
| 36. | 115. | -107. | 139. | -100. | | | | |
| 48. | 118. | -112. | 137. | -104. | | | | |
| 60. | 109. | -105. | 123. | -97. | | | | |
| 72. | 91. | -90. | 99. | -84. | | | | |
| 84. | 70. | -71. | 74. | -66. | | | | |
| 96. | 48. | -50. | 50. | -46. | | | | |
| 108. | 28. | -33. | 30. | -30. | | | | |
| AT LOAD POINT: | | | | | | | | |
| DEFL | .12 | -.11 | .13 | -.10 | | | | |
| SLOPE | -.00185 | .00178 | -.00196 | .00176 | | | | |
| LOAD | 2.90 | -2.49 | 3.74 | -2.38 | | | | |

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* HOUSTON PILE STUDY *
* FIELD DATA FROM LATERAL LOAD TEST OF OCT 11, 1984 *
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LOAD NO. 2

UNITS - INCHES,KIPS,RADIANS

| DEPTH, INCHES | BENDING MOMENTS, INCH-KIPS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CYCLE 1001 | CYCLE 2001 | CYCLE 1005 | CYCLE 2005 | CYCLE 1010 | CYCLE 2010 | CYCLE 1020 | CYCLE 2020 |
| 0. | 98. | -92. | 82. | -79. | 84. | -84. | 94. | -77. |
| 6. | 145. | -137. | 122. | -117. | 126. | -123. | 140. | -114. |
| 12. | 191. | -182. | 162. | -155. | 165. | -164. | 183. | -153. |
| 24. | 267. | -256. | 232. | -223. | 238. | -232. | 259. | -221. |
| 36. | 311. | -301. | 281. | -267. | 287. | -276. | 308. | -266. |
| 48. | 321. | -313. | 298. | -287. | 304. | -294. | 321. | -286. |
| 60. | 298. | -295. | 284. | -277. | 289. | -283. | 301. | -275. |
| 72. | 254. | -258. | 247. | -247. | 244. | -256. | 250. | -247. |
| 84. | 203. | -209. | 199. | -203. | 201. | -204. | 204. | -199. |
| 96. | 149. | -155. | 147. | -153. | 148. | -153. | 149. | -149. |
| 108. | 99. | -104. | 99. | -105. | 99. | -105. | 98. | -103. |
| AT LOAD POINT: | | | | | | | | |
| DEFL | .34 | -.33 | .33 | -.32 | .33 | -.32 | .34 | -.31 |
| SLOPE | -.00496 | .00506 | -.00470 | .00487 | -.00483 | .00486 | -.00491 | .00480 |
| LOAD | 7.90 | -7.42 | 6.59 | -6.35 | 6.69 | -6.72 | 7.56 | -6.12 |

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*                 HOUSTON PILE STUDY                     *
* FIELD DATA FROM LATERAL LOAD TEST OF OCT 11, 1984 *
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LOAD NO. 2

UNITS - INCHES,KIPS,RADIANS

| DEPTH, INCHES | BENDING MOMENTS, INCH-KIPS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CYCLE 1050 | CYCLE 2050 | CYCLE 1100 | CYCLE 2100 | CYCLE 1200 | CYCLE 2200 | CYCLE | CYCLE |
| 0. | 99. | -90. | 102. | -89. | 108. | -98. | | |
| 6. | 146. | -132. | 151. | -132. | 158. | -146. | | |
| 12. | 192. | -176. | 199. | -177. | 209. | -194. | | |
| 24. | 271. | -250. | 280. | -253. | 294. | -275. | | |
| 36. | 321. | -295. | 331. | -298. | 346. | -321. | | |
| 48. | 332. | -310. | 341. | -312. | 351. | -331. | | |
| 60. | 308. | -293. | 314. | -292. | 319. | -305. | | |
| 72. | 253. | -265. | 258. | -256. | 260. | -262. | | |
| 84. | 204. | -205. | 203. | -201. | 199. | -205. | | |
| 96. | 146. | -151. | 143. | -148. | 138. | -149. | | |
| 108. | 94. | -102. | 91. | -100. | 85. | -100. | | |
| AT LOAD POINT: | | | | | | | | |
| DEFL | .34 | -.32 | .34 | -.32 | .33 | -.32 | | |
| SLOPE | -.00498 | .00489 | -.00508 | .00487 | -.00512 | .00515 | | |
| LOAD | 7.93 | -7.18 | 8.20 | -7.08 | 8.66 | -7.83 | | |

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*                 HOUSTON PILE STUDY                *
* FIELD DATA FROM LATERAL LOAD TEST OF OCT 11, 1984 *
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LOAD NO. [illegible]

UNITS - INCHES,KIPS,RADIANS

| DEPTH, INCHES | BENDING MOMENTS, INCH-KIPS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CYCLE 1001 | CYCLE 2001 | CYCLE 1005 | CYCLE 2005 | CYCLE 1010 | CYCLE 2010 | CYCLE 1020 | CYCLE 2020 |
| 0. | [illegible] | -13[illegible]. | 140. | -1[illegible]5. | 137. | -121. | 134. | -127. |
| 6. | [illegible] | -207. | 206. | -187. | 202. | -180. | 198. | -189. |
| 12. | [illegible]4. | -276. | 274. | -250. | 268. | -242. | 262. | -253. |
| 24. | 413. | -[illegible] | 389. | -356. | 383. | -349. | 377. | -361. |
| 36. | 45[illegible]. | -471. | 46[illegible]. | -428. | 458. | -420. | 453. | -431. |
| 48. | 4[illegible]. | -478. | 486. | -453. | 479. | -447. | 476. | -456. |
| 60. | 4[illegible]8. | -446. | 456. | -432. | 450. | -428. | 448. | -435. |
| 72. | 384. | -386. | 389. | -381. | 387. | -379. | 382. | -384. |
| 84. | 307. | -309. | 311. | -310. | 305. | -309. | 305. | -312. |
| [illegible] | 21[illegible]. | -2[illegible]. | 228. | -235. | 224. | -235. | 223. | -236. |
| 10[illegible]. | 143. | -1[illegible]8. | 152. | -165. | 149. | -165. | 148. | -166. |
| AT LOAD POINT: | | | | | | | | |
| DEFL | .50 | -.4[illegible] | .50 | -.49 | .49 | -.49 | .49 | -.50 |
| SLOPE | -.00751 | .00754 | -.00755 | .00748 | -.00749 | .00741 | -.00742 | .00743 |
| LOAD | 1[illegible].00 | -11.14 | 11.18 | -10.03 | 10.54 | -9.67 | 10.73 | -10.26 |

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*                    HOUSTON PILE STUDY                    *
* FIELD DATA FROM LATERAL LOAD TEST OF OCT 11, 1984 *
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LOAD NO. 3

UNITS - INCHES, KIPS, RADIANS

| DEPTH, INCHES | CYCLE 1050 | CYCLE 2050 | CYCLE 1100 | CYCLE 2100 | CYCLE 1200 | CYCLE 2200 | CYCLE | CYCLE |
|---|---|---|---|---|---|---|---|---|
| | BENDING MOMENTS, INCH-KIPS | | | | | | | |
| 0. | 141. | -129. | 146. | -131. | 147. | -136. | | |
| 6. | 208. | -192. | 215. | -195. | 216. | -205. | | |
| 12. | 275. | -257. | 284. | -261. | 286. | -274. | | |
| 24. | 395. | -368. | 407. | -375. | 411. | -394. | | |
| 36. | 474. | -429. | 486. | -447. | 492. | -467. | | |
| 48. | 495. | -463. | 506. | -469. | 512. | -486. | | |
| 60. | 463. | -440. | 471. | -445. | 474. | -457. | | |
| 72. | 391. | -387. | 394. | -388. | 396. | -392. | | |
| 84. | 311. | -312. | 310. | -311. | 307. | -313. | | |
| 96. | 225. | -234. | 222. | -232. | 218. | -232. | | |
| 108. | 146. | -163. | 144. | -161. | 139. | -159. | | |
| AT LOAD POINT: | | | | | | | | |
| DEFL | .50 | -.50 | .50 | -.50 | .50 | -.49 | | |
| SLOPE | -.00754 | .00750 | -.00771 | .00754 | -.00781 | .00769 | | |
| LOAD | 11.30 | -10.43 | 11.73 | -10.59 | 11.76 | -11.06 | | |

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*                 HOUSTON PILE STUDY                *
* FIELD DATA FROM LATERAL LOAD TEST OF OCT 11, 1984 *
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LOAD NO. 4

UNITS - INCHES,KIPS,RADIANS

| DEPTH, INCHES | CYCLE 1001 | CYCLE 2001 | CYCLE 1005 | CYCLE 2005 | CYCLE 1010 | CYCLE 2010 | CYCLE 1020 | CYCLE 2020 |
|---|---|---|---|---|---|---|---|---|
| | BENDING MOMENTS, INCH-KIPS | | | | | | | |
| 0. | [illegible] | -196. | 185. | -172. | 188. | -171. | 184. | -167. |
| 6. | [illegible] | -276. | 272. | -256. | 276. | -254. | 270. | -248. |
| 12. | 367. | -368. | 360. | -341. | 366. | -339. | 357. | -331. |
| 24. | 517. | -534. | 519. | -494. | 527. | -493. | 518. | -483. |
| 36. | 666. | -639. | 629. | -596. | 636. | -595. | 630. | -587. |
| 48. | [illegible] | -669. | 668. | -633. | 674. | -633. | 669. | -626. |
| 60. | 645. | -635. | 634. | -612. | 639. | -613. | 637. | -608. |
| 72. | 552. | -557. | 541. | -559. | 542. | -551. | 542. | -545. |
| 84. | 440. | -450. | 442. | -447. | 445. | -450. | 443. | -447. |
| 96. | 334. | -341. | 330. | -344. | 331. | -347. | 330. | -344. |
| 108. | 217. | -240. | 223. | -248. | 224. | -250. | 223. | -248. |
| AT LOAD POINT: | | | | | | | | |
| DEFL | .72 | -.72 | .71 | -.72 | .71 | -.72 | .71 | -.71 |
| SLOPE | -.01067 | .01083 | -.01042 | .01053 | -.01042 | .01046 | -.01044 | .01047 |
| LOAD | 15.73 | -14.85 | 14.82 | -13.87 | 14.98 | -13.73 | 14.56 | -13.40 |

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*                  HOUSTON PILE STUDY              *
* FIELD DATA FROM LATERAL LOAD TEST OF OCT 11, 1984 *
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LOAD NO. 4

UNITS - INCHES,KIPS,RADIANS

| DEPTH, INCHES | BENDING MOMENTS, INCH-KIPS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CYCLE 1050 | CYCLE 2050 | CYCLE 1100 | CYCLE 2100 | CYCLE 1200 | CYCLE 2200 | CYCLE | CYCLE |
| 0. | 190. | -168. | 190. | -173. | 197. | -177. | | |
| 6. | 280. | -250. | 279. | -257. | 289. | -262. | | |
| 12. | 370. | -333. | 369. | -343. | 362. | -349. | | |
| 24. | 536. | -486. | 536. | -500. | 553. | -512. | | |
| 36. | 647. | -551. | 651. | -606. | 675. | -620. | | |
| 48. | 686. | -630. | 691. | -642. | 711. | -655. | | |
| 60. | 650. | -612. | 652. | -622. | 667. | -629. | | |
| 72. | 554. | -545. | 556. | -551. | 565. | -549. | | |
| 84. | 447. | -446. | 445. | -447. | 446. | -444. | | |
| 96. | 330. | -342. | 326. | -339. | 323. | -335. | | |
| 108. | 236. | -245. | 216. | -242. | 212. | -237. | | |
| AT LOAD POINT: | | | | | | | | |
| DEFL | .71 | -.71 | .71 | -.71 | .72 | -.71 | | |
| SLOPE | -.01057 | .01051 | -.01054 | .01071 | -.01071 | .01083 | | |
| LOAD | 15.13 | -13.47 | 15.05 | -13.91 | 15.61 | -14.18 | | |

* HOUSTON PILE STUDY *
* FIELD DATA FROM LATERAL LOAD TEST OF OCT 11, 1984 *

LOAD NO. [illegible]

UNITS - INCHES,KIPS,RADIANS

| DEPTH, INCHES | BENDING MOMENTS, INCH-KIPS CYCLE 1001 | CYCLE 2001 | CYCLE 1005 | CYCLE 2005 | CYCLE 1010 | CYCLE 2010 | CYCLE 1020 | CYCLE 2020 |
|---|---|---|---|---|---|---|---|---|
| 0. | [illegible] | [illegible] | 247. | -218. | 233. | -212. | 236. | -211. |
| 6. | [illegible] | [illegible] | 356. | -325. | 342. | -316. | 346. | -314. |
| 12. | 453. | [illegible] | 470. | -432. | 452. | -421. | 457. | -418. |
| 24. | [illegible] | [illegible] | 681. | -635. | 658. | -619. | 669. | -616. |
| 36. | [illegible] | [illegible] | 835. | -776. | 809. | -762. | 819. | -759. |
| 48. | [illegible] | [illegible] | 900. | -820. | 880. | -804. | 909. | -772. |
| 60. | [illegible] | [illegible] | 851. | -812. | 830. | -807. | 838. | -804. |
| 72. | 741. | -749. | 777. | -731. | 721. | -729. | 728. | -726. |
| 84. | [illegible] | [illegible] | 602. | -604. | 590. | -605. | 591. | -602. |
| 96. | [illegible] | [illegible] | 455. | -470. | 445. | -473. | 443. | -470. |
| 108. | [illegible] | -331. | 313. | -344. | 307. | -347. | 302. | -346. |
| AT LOAD POINT: | | | | | | | | |
| DEFL | .97 | -.96 | .97 | -.96 | .96 | -.96 | .96 | -.96 |
| SLOPE | [illegible] | [illegible] | -.01358 | .01409 | -.01327 | .01414 | -.01315 | .01411 |
| LOAD | [illegible] | [illegible] | 19.13 | -17.49 | 18.33 | -16.99 | 18.49 | -16.93 |

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*                 HOUSTON PILE STUDY                  *
* FIELD DATA FROM LATERAL LOAD TEST OF OCT 11, 1984 *
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LOAD NO. 5

UNITS - INCHES,KIPS,RADIANS

| DEPTH, INCHES | BENDING MOMENTS, INCH-KIPS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | CYCLE 1050 | CYCLE 2050 | CYCLE 1100 | CYCLE 2100 | CYCLE 1200 | CYCLE 2200 | CYCLE | CYCLE |
| 0. | 239. | -209. | 241. | -216. | 244. | -220. | | |
| 6. | 351. | -311. | 354. | -321. | 358. | -328. | | |
| 12. | 464. | -414. | 469. | -427. | 473. | -435. | | |
| 24. | 678. | -611. | 685. | -630. | 694. | -641. | | |
| 36. | 831. | -755. | 841. | -776. | 853. | -794. | | |
| 48. | 932. | -756. | 964. | -763. | 1047. | -669. | | |
| 60. | 849. | -801. | 857. | -813. | 876. | -813. | | |
| 72. | 737. | -722. | 742. | -726. | 747. | -731. | | |
| 84. | 597. | -599. | 596. | -601. | 595. | -601. | | |
| 96. | 446. | -467. | 442. | -464. | 438. | -462. | | |
| 108. | 303. | -344. | 298. | -338. | 292. | -334. | | |
| AT LOAD POINT: | | | | | | | | |
| DEFL | .96 | -.96 | .96 | -.96 | .96 | -.96 | | |
| SLOPE | -.01323 | .01413 | -.01330 | .01426 | -.01329 | .01444 | | |
| LOAD | 18.75 | -16.74 | 18.88 | -17.33 | 18.97 | -17.74 | | |

HOUSTON PILE STUDY

FIELD DATA FROM LATERAL LOAD TEST OF OCT 11, 1984

LOAD NO. 6

UNITS - INCHES,KIPS,RADIANS

| DEPTH, INCHES | BENDING MOMENTS, INCH-KIPS CYCLE 1001 | CYCLE 2001 | CYCLE | CYCLE | CYCLE | CYCLE | CYCLE | CYCLE |
|---|---|---|---|---|---|---|---|---|
| 0. | 283. | -263. | | | | | | |
| 6. | 416. | -391. | | | | | | |
| 12. | 550. | -520. | | | | | | |
| 24. | 808. | -767. | | | | | | |
| 36. | 991. | -947. | | | | | | |
| 48. | 1177. | -802. | | | | | | |
| 60. | 1011. | -959. | | | | | | |
| 72. | 867. | -866. | | | | | | |
| 84. | 694. | -712. | | | | | | |
| 96. | 515. | -549. | | | | | | |
| 108. | 348. | -398. | | | | | | |
| AT LOAD POINT: | | | | | | | | |
| DEFL | 1.12 | -1.13 | | | | | | |
| SLOPE | -.01562 | .01694 | | | | | | |
| LOAD | 22.04 | -21.04 | | | | | | |

HOUSTON PILE STUDY

FIELD DATA FROM LATERAL LOAD TEST OF OCT 11, 1984

LOAD NO. 7

UNITS - INCHES,KIPS,RADIANS

| DEPTH, INCHES | BENDING MOMENTS, INCH-KIPS CYCLE 1001 | CYCLE 2001 | CYCLE 1005 | CYCLE 2005 | CYCLE 1010 | CYCLE 2010 | CYCLE 1020 | CYCLE 2020 |
|---|---|---|---|---|---|---|---|---|
| 0. | 314. | -284. | 297. | -264. | 293. | -264. | 293. | -256. |
| 6. | 460. | -422. | 434. | -394. | 428. | -394. | 429. | -384. |
| 12. | 608. | -560. | 574. | -523. | 567. | -524. | 567. | -510. |
| 24. | 893. | -830. | 840. | -776. | 829. | -777. | 830. | -757. |
| 36. | 1098. | -1032. | 1036. | -971. | 1027. | -971. | 1029. | -951. |
| 48. | 1328. | -850. | 1351. | -651. | 1405. | -700. | 1404. | -683. |
| 60. | 1137. | -1056. | 1147. | -976. | 1154. | -966. | 1163. | -937. |
| 72. | 978. | -969. | 960. | -961. | 961. | -956. | 963. | -947. |
| 84. | 792. | -803. | 793. | -806. | 794. | -801. | 795. | -797. |
| 96. | 598. | -627. | 607. | -638. | 610. | -634. | 609. | -631. |
| 108. | 414. | -461. | 427. | -477. | 430. | -475. | 428. | -473. |
| AT LOAD POINT: | | | | | | | | |
| DEFL | 1.29 | -1.29 | 1.29 | -1.29 | 1.29 | -1.29 | 1.29 | -1.28 |
| SLOPE | -.01764 | .01885 | -.01704 | .01863 | -.01697 | .01868 | -.01702 | .01839 |
| LOAD | 24.29 | -22.80 | 22.76 | -21.54 | 22.44 | -21.46 | 22.43 | -20.93 |

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* HOUSTON PILE STUDY *

* FIELD DATA FROM LATERAL LOAD TEST OF OCT 11, 1984 *

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LOAD NO. 7

UNITS - INCHES,KIPS,RADIANS

| DEPTH, | BENDING MOMENTS, INCH-KIPS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| INCHES | CYCLE | CYCLE | CYCLE | CYCLE | CYCLE | CYCLE | CYCLE | CYCLE |
| | 1050 | 2050 | 1100 | 2100 | | | | |
| 0. | 295. | -265. | 293. | -263. | | | | |
| 6. | 432. | -396. | 428. | -394. | | | | |
| 12. | 571. | -526. | 566. | -524. | | | | |
| 24. | 837. | -780. | 831. | -779. | | | | |
| 36. | 1038. | -981. | 1030. | -978. | | | | |
| 48. | 1449. | -631. | 1506. | -484. | | | | |
| 60. | 1205. | -896. | 1311. | -587. | | | | |
| 72. | 971. | -960. | 966. | -963. | | | | |
| 84. | 798. | -803. | 794. | -805. | | | | |
| 96. | 609. | -632. | 602. | -632. | | | | |
| 108. | 426. | -470. | 418. | -470. | | | | |
| AT LOAD POINT: | | | | | | | | |
| DEFL | 1.29 | -1.28 | 1.27 | -1.29 | | | | |
| SLOPE | -.01704 | .01860 | -.01727 | .01855 | | | | |
| LOAD | 22.58 | -21.63 | 22.29 | -21.44 | | | | |

HOUSTON PILE STUDY

FIELD DATA FROM LATERAL LOAD TEST OF OCT 11, 1984

LOAD NO. 8

UNITS - INCHES,KIPS,RADIANS

| DEPTH, | BENDING MOMENTS, INCH-KIPS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| INCHES | CYCLE | CYCLE | CYCLE | CYCLE | CYCLE | CYCLE | CYCLE | CYCLE |
| | 1001 | 2001 | | | | | | |
| 0. | 341. | -318. | | | | | | |
| 6. | 498. | -475. | | | | | | |
| 12. | 659. | -631. | | | | | | |
| 24. | 967. | -937. | | | | | | |
| 36. | 1182. | -1171. | | | | | | |
| 48. | 1619. | -667. | | | | | | |
| 60. | 1424. | -465. | | | | | | |
| 72. | 1127. | -1140. | | | | | | |
| 84. | 925. | -949. | | | | | | |
| 96. | 707. | -743. | | | | | | |
| 108. | 498. | -550. | | | | | | |
| AT LOAD POINT: | | | | | | | | |
| DEFL | 1.50 | -1.51 | | | | | | |
| SLOPE | -.02010 | .02197 | | | | | | |
| LOAD | 25.92 | -25.83 | | | | | | |

HCUSTON PILE STUDY

FIELD DATA FROM LATERAL LOAD TEST OF OCT 11, 1984

LOAD NO. 9

UNITS - INCHES,KIPS,RADIANS

| DEPTH, INCHES | BENDING MOMENTS, INCH-KIPS CYCLE 1001 | CYCLE 2001 | CYCLE 1005 | CYCLE 2005 | CYCLE 1010 | CYCLE 2010 | CYCLE 1020 | CYCLE 2020 |
|---|---|---|---|---|---|---|---|---|
| 0. | 364. | -328. | 349. | -297. | 338. | -297. | 343. | -294. |
| 6. | 533. | -490. | 509. | -444. | 493. | -445. | 500. | -441. |
| 12. | 704. | -651. | 673. | -590. | 652. | -591. | 662. | -586. |
| 24. | 1034. | -969. | 988. | -877. | 959. | -878. | 974. | -872. |
| 36. | 1268. | -1217. | 1214. | -1115. | 1183. | -1117. | 1196. | -1110. |
| 48. | 1721. | -623. | 1741. | -380. | 1749. | -521. | 1748. | -468. |
| 60. | 1613. | -145. | 1767. | 44. | 1490. | -490. | 1474. | -516. |
| 72. | 1205. | -1218. | 1191. | -1178. | 1177. | -1185. | 1184. | -1185. |
| 84. | 995. | -1018. | 992. | -1005. | 989. | -1009. | 988. | -1008. |
| 96. | 769. | -799. | 780. | -799. | 783. | -801. | 781. | -799. |
| 108. | 546. | -599. | 563. | -611. | 570. | -613. | 565. | -612. |
| AT LOAD POINT: | | | | | | | | |
| DEFL | 1.62 | -1.63 | 1.63 | -1.61 | 1.63 | -1.62 | 1.63 | -1.61 |
| SLOPE | -.02176 | .02313 | -.02154 | .02260 | -.02126 | .02235 | -.02144 | .02243 |
| LOAD | 27.75 | -26.59 | 26.71 | -24.00 | 25.78 | -24.05 | 26.26 | -23.71 |

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* HOUSTON PILE STUDY *

* FIELD DATA FROM LATERAL LOAD TEST OF OCT 11, 1984 *

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LOAD NO. 10

UNITS - INCHES,KIPS,RADIANS

| DEPTH, | BENDING MOMENTS, INCH-KIPS | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| INCHES | CYCLE | CYCLE | CYCLE | CYCLE | CYCLE | CYCLE | CYCLE | CYCLE |
| | 1001 | 2001 | 1010 | | | | | |
| 0. | 415. | -385. | 395. | | | | | |
| 6. | 607. | -576. | 577. | | | | | |
| 12. | 803. | -765. | 764. | | | | | |
| 24. | 1184. | -1138. | 1131. | | | | | |
| 36. | 1394. | -1387. | 224430. | | | | | |
| 48. | -8993. | -7530. | -11632. | | | | | |
| 60. | -5765. | -2236. | -16541. | | | | | |
| 72. | -316. | -4611. | -13225. | | | | | |
| 84. | 1256. | -1188. | 1280. | | | | | |
| 96. | 985. | -995. | 982. | | | | | |
| 108. | 718. | -759. | 723. | | | | | |
| AT LOAD POINT: | | | | | | | | |
| DEFL | 2.09 | -2.10 | 2.06 | | | | | |
| SLOPE | -.02783 | .02913 | -.02746 | | | | | |
| LOAD | 31.89 | -30.75 | 30.92 | | | | | |

# APPENDIX B

Results of the load test of the group of piles,
October 18, 1984

* HOUSTON PILE GROUP STUDY *
* FIELD DATA FROM LATERAL LOAD TEST OF OCT 18, 1984 *

| | | |
|---|---|---|
| | NORTH | |
| D | G | A |
| F | E | H |
| B | I | C |
| | PILE LEGEND | |

LOAD NO. 1
CYCLE NO. [illegible]
LOAD ON GROUP = 35.24 FROM BIG LOAD CELL, KIPS
= 35.69 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -2.66588 INCHES
WEST CAP DEFL = -3.27942 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 95. | 99. | [illegible] | 128. | 82. | 93. | 109. | 78. | 57. | 92. |
| 24. | 127. | 140. | 124. | 168. | 104. | 132. | 134. | 108. | 96. | 126. |
| 36. | 133. | 152. | 143. | [illegible] | 111. | 141. | 141. | 131. | 124. | 140. |
| 48. | 132. | 157. | 148. | 185. | 140. | 153. | 166. | 135. | 130. | 150. |
| 60. | 133. | 160. | 146. | 173. | 135. | 156. | 157. | 135. | 126. | 147. |
| 72. | 114. | 155. | 132. | 155. | 131. | 145. | 135. | 127. | 133. | 136. |
| 84. | 79. | 132. | 117. | 124. | 115. | 134. | 124. | 113. | 121. | 119. |
| 96. | 77. | 114. | 96. | 97. | 128. | 106. | 96. | 95. | 91. | 100. |
| 114. | 59. | 81. | [illegible] | 64. | 79. | 82. | 67. | 67. | 71. | 70. |
| 132. | 32. | 49. | [illegible] | 37. | 58. | 50. | 45. | 41. | 42. | 43. |
| 156. | 14. | 15. | 11. | 16. | 25. | 20. | 19. | 15. | 15. | 17. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .17 | .20 | .15 | .19 | .19 | .20 | .19 | .17 | .19 | .18 |
| SLOPE | -.[illegible]221 | -.00258 | -.[illegible]229 | -.[illegible]30[illegible] | -.00205 | -.00232 | -.00232 | -.00224 | -.00217 | -.00235 |
| LOAD | 4.74 | 4.18 | 3.57 | 5.07 | 3.59 | 4.00 | 4.26 | 3.07 | 3.22 | 3.97 |

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*****************************************************
*             HOUSTON PILE GROUP STUDY              *
* FIELD DATA FROM LATERAL LOAD TEST OF OCT 18, 1984 *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 1
CYCLE NO. 2.01
LOAD ON GROUP = -37.50 FROM BIG LOAD CELL, KIPS
= -35.98 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -3.03555 INCHES
WEST CAP DEFL = -3.68482 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -76. | -131. | -126. | -80. | -87. | -76. | -79. | -91. | -110. | -94. |
| 24. | -110. | -180. | -168. | -112. | -116. | -107. | -108. | -128. | -156. | -132. |
| 36. | -113. | -203. | -187. | -141. | -130. | -123. | -126. | -155. | -178. | -151. |
| 48. | -130. | -199. | -182. | -151. | -149. | -134. | -145. | -159. | -175. | -158. |
| 60. | -129. | -194. | -166. | -160. | -153. | -139. | -134. | -155. | -163. | -154. |
| 72. | -122. | -159. | -138. | -155. | -144. | -144. | -141. | -141. | -125. | -141. |
| 84. | -112. | -115. | -109. | -137. | -119. | -112. | -121. | -117. | -95. | -115. |
| 96. | -87. | -95. | -82. | -109. | -84. | -104. | -100. | -91. | -71. | -91. |
| 114. | -57. | -52. | -51. | -72. | -76. | -72. | -70. | -55. | -34. | -60. |
| 132. | -31. | -25. | -23. | -37. | -47. | -44. | -39. | -23. | -24. | -33. |
| 156. | -7. | -9. | -7. | -11. | -17. | -14. | -12. | -9. | -10. | -11. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.13 | -.16 | -.14 | -.16 | -.16 | -.15 | -.15 | -.15 | -.17 | -.15 |
| SLOPE | .00265 | .00298 | .00285 | .00304 | .00248 | .00244 | .00252 | .00257 | .00267 | .00267 |
| LOAD | -3.37 | -3.58 | -4.79 | -3.43 | -3.72 | -4.03 | -3.16 | -3.43 | -4.48 | -4.00 |

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HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF OCT 18, 1984

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LOAD NO. 1
CYCLE NO. 1.05
LOAD ON GROUP = 36.73 FROM BIG LOAD CELL, KIPS
= 38.41 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -2.73356 INCHES
WEST CAP DEFL = -3.27459 INCHES

NORTH

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|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 113. | 94. | 96. | 156. | 57. | 101. | 127. | 80. | 53. | 102. |
| 24. | 154. | 138. | 134. | 209. | 125. | 145. | 159. | 114. | 91. | 141. |
| 36. | 153. | 133. | 159. | 241. | 139. | 162. | 175. | 143. | 122. | 162. |
| 48. | 169. | 166. | 173. | 246. | 177. | 182. | 210. | 157. | 140. | 179. |
| 60. | 177. | 178. | 173. | 238. | 178. | 197. | 208. | 165. | 138. | 183. |
| 72. | 155. | 181. | 166. | 218. | 176. | 187. | 188. | 165. | 154. | 177. |
| 84. | 129. | 165. | 151. | 186. | 158. | 186. | 172. | 153. | 151. | 161. |
| 96. | 108. | 147. | 130. | 141. | 176. | 149. | 136. | 134. | 122. | 138. |
| 114. | 82. | 119. | 98. | 91. | 109. | 122. | 95. | 102. | 110. | 103. |
| 132. | 40. | 65. | 61. | 53. | 83. | 79. | 62. | 68. | 74. | 68. |
| 156. | 20. | 32. | 23. | 24. | 38. | 34. | 27. | 26. | 31. | 28. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .21 | .25 | .14 | .26 | .24 | .26 | .25 | .22 | .24 | .23 |
| SLOPE | -.00292 | -.00336 | -.00361 | -.00411 | -.00277 | -.00308 | -.00308 | -.00291 | -.00272 | -.00317 |
| LOAD | 3.34 | 4.46 | 3.40 | 5.72 | 4.24 | 4.14 | 4.64 | 3.35 | 3.11 | 4.27 |

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*              HOUSTON PILE GROUP STUDY              *
*  FIELD DATA FROM LATERAL LOAD TEST OF OCT 18, 1984 *
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NORTH

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|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 1
CYCLE NO. 2705
LOAD ON GROUP = -23.37 FROM JIG LOAD CELL, KIPS
= -21.72 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -2.95367 INCHES
WEST CAP DEFL = -3.67232 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -47. | -96. | -79. | -36. | -53. | -40. | -52. | -67. | -91. | -62. |
| 24. | -86. | -129. | -113. | -58. | -76. | -61. | -74. | -96. | -135. | -91. |
| 36. | -84. | -159. | -139. | -82. | -88. | -75. | -90. | -122. | -161. | -111. |
| 48. | -100. | -165. | -146. | -93. | -107. | -90. | -104. | -131. | -165. | -122. |
| 60. | -104. | -159. | -142. | -137. | -117. | -97. | -95. | -132. | -161. | -124. |
| 72. | -101. | -141. | -119. | -108. | -114. | -105. | -106. | -123. | -121. | -115. |
| 84. | -95. | -98. | -95. | -98. | -54. | -77. | -90. | -101. | -88. | -93. |
| 96. | -75. | -76. | -76. | -78. | -52. | -73. | -75. | -76. | -57. | -70. |
| 114. | -47. | -31. | -33. | -52. | -57. | -45. | -51. | -39. | -12. | -41. |
| 132. | -26. | -4. | -12. | -25. | -32. | -22. | -25. | -14. | -2. | -18. |
| 156. | -3. | 3. | 1. | -6. | -7. | -4. | -6. | -1. | 4. | -2. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.11 | -.13 | -.08 | -.12 | -.12 | -.11 | -.11 | -.12 | -.13 | -.11 |
| SLOPE | .00204 | .00280 | .00253 | .00181 | .00175 | .00143 | .00174 | .00200 | .00221 | .00192 |
| LOAD | -2.28 | -3.11 | -3.07 | -1.81 | -1.94 | -2.14 | -2.08 | -1.92 | -3.37 | -2.41 |

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*                HOUSTON PILE GROUP STUDY                  *
*  FIELD DATA FROM LATERAL LOAD TEST OF OCT 18, 1984       *
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NORTH

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|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 1
CYCLE NO. [illegible]10
LOAD ON GROUP = 39.[illegible]9 FROM BIG LOAD CELL, KIPS
= [illegible] FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -2.75923 INCHES
WEST CAP DEFL = -3.26777 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 113. | 93. | 93. | 156. | 96. | 99. | 128. | 77. | 49. | 100. |
| 24. | 154. | 132. | [illegible] | 213. | 125. | 143. | 162. | 110. | 86. | 139. |
| 36. | 165. | 148. | 155. | 246. | 139. | 161. | 179. | 139. | 117. | 161. |
| 48. | 172. | [illegible] | 167. | 253. | 178. | 182. | 215. | 154. | 135. | 180. |
| 60. | 191. | 177. | 171. | 248. | 181. | 200. | 215. | 164. | 135. | 186. |
| 72. | [illegible] | 182. | 168. | 230. | 180. | 193. | 197. | 167. | 153. | 181. |
| 84. | 134. | 169. | 153. | 196. | 164. | 195. | 181. | 158. | 153. | 166. |
| 96. | 111. | 152. | 133. | 149. | 189. | 158. | 142. | 140. | 125. | 144. |
| 114. | 85. | 126. | [illegible] | 96. | 114. | 132. | 99. | 109. | 117. | 109. |
| 132. | 47. | 93. | [illegible] | 57. | 88. | 87. | 64. | 74. | 81. | 73. |
| 156. | [illegible] | 37. | 26. | 26. | 41. | 37. | 28. | 29. | 36. | 31. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .22 | .26 | .13 | .27 | .25 | .27 | .26 | .23 | .25 | .24 |
| SLOPE | -.00314 | -.00347 | -.00346 | -.00442 | -.00291 | -.00325 | -.00327 | -.00302 | -.00276 | -.00336 |
| LOAD | 5.88 | 4.09 | 3.49 | 5.34 | 4.54 | 4.30 | 5.00 | 3.51 | 3.16 | 4.51 |

HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF OCT 18, 1984

| | | | |
|---|---|---|---|
| | NORTH | | |
| | D | G | A |
| | F | E | H |
| | B | I | C |
| | PILE LEGEND | | |

LOAD NO. 1
CYCLE NO. 2010
LOAD ON GROUP = -31.96 FROM BIG LOAD CELL, KIPS
= -29.53 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -2.95015 INCHES
WEST CAP DEFL = -3.67162 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -59. | -116. | -106. | -49. | -73. | -55. | -64. | -84. | -115. | -86. |
| 24. | -95. | -162. | -146. | -74. | -95. | -80. | -89. | -118. | -165. | -114. |
| 36. | -99. | [illegible] | [illegible] | -98. | -107. | -94. | -105. | -145. | -191. | -133. |
| 48. | -115. | -192. | -173. | -108. | -126. | -108. | -121. | -152. | -191. | -143. |
| 60. | -118. | -180. | -164. | -120. | -134. | -112. | -109. | -150. | -181. | -141. |
| 72. | -112. | -157. | -135. | -119. | -128. | -117. | -118. | -137. | -136. | -129. |
| 84. | -105. | -107. | -105. | -107. | -103. | -85. | -99. | -111. | -97. | -102. |
| 96. | -42. | -80. | -76. | -84. | -53. | -77. | -82. | -82. | -61. | -75. |
| 114. | -33. | -30. | -37. | -55. | -61. | -45. | -56. | -40. | -11. | -43. |
| 132. | -28. | -1. | -11. | -25. | -33. | -20. | -27. | -13. | 1. | -17. |
| 156. | -4. | 6. | 2. | -5. | -6. | -3. | -6. | 0. | 6. | -1. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.11 | -.12 | -.08 | -.11 | -.12 | -.10 | -.11 | -.12 | -.14 | -.11 |
| SLOPE | .00261 | .00259 | .00330 | .00242 | .00229 | .00197 | .00224 | .00253 | .00273 | .00252 |
| LOAD | -2.89 | -4.34 | -4.28 | -2.50 | -2.67 | -3.04 | -2.67 | -2.60 | -4.55 | -3.28 |

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*               HOUSTON PILE GROUP STUDY              *
*  FIELD DATA FROM LATERAL LOAD TEST OF OCT 18, 1984  *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 1
CYCLE NO. [illegible]
LOAD ON GROUP = 33.86 FROM BIG LOAD CELL, KIPS
= 36.21 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -2.78119 INCHES
WEST CAP DEFL = -3.26306 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | [illegible] | 84. | 68. | 155. | 92. | 94. | 126. | 71. | 44. | 96. |
| 24. | 132. | 124. | 124. | 211. | 121. | 137. | 160. | 103. | 77. | 134. |
| 36. | 154. | 141. | 149. | 247. | 136. | 156. | 181. | 132. | 109. | 157. |
| 48. | 174. | 156. | 163. | 258. | 176. | 178. | 218. | 153. | 129. | 178. |
| 60. | 186. | 174. | 171. | 256. | 182. | 201. | 224. | 163. | 130. | 187. |
| 72. | 167. | 182. | 172. | 240. | 184. | 196. | 207. | 169. | 150. | 185. |
| 84. | 142. | 171. | 158. | 202. | 169. | 204. | 191. | 163. | 154. | 173. |
| 96. | 119. | 157. | 14[illegible]. | 161. | 198. | 169. | 151. | 148. | 128. | 152. |
| 114. | 92. | 135. | 108. | 106. | 123. | 145. | 106. | 119. | 124. | 117. |
| 132. | 52. | 134. | 74. | 64. | 97. | 99. | 69. | 84. | 90. | 81. |
| 156. | 22. | 44. | 30. | 29. | 46. | 44. | 30. | 34. | 42. | 36. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .23 | .29 | .14 | .29 | .27 | .30 | .28 | .24 | .26 | .26 |
| SLOPE | -.00297 | -.00321 | -.00399 | -.00432 | -.00277 | -.00309 | -.00319 | -.00288 | -.00271 | -.00324 |
| LOAD | 5.23 | 4.18 | 2.98 | 5.39 | 4.17 | 3.83 | 4.50 | 3.20 | 2.74 | 4.02 |

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*                 HOUSTON PILE GROUP STUDY                   *
*  FIELD DATA FROM LATERAL LOAD TEST OF OCT 18, 1984         *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 1
CYCLE NO. 2320
LOAD ON GROUP = -23.57 FROM BIG LOAD CELL, KIPS
= -22.19 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -2.76225 INCHES
WEST CAP DEFL = -3.66066 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -46. | -100. | -88. | -32. | -56. | -42. | -59. | -72. | -104. | -65. |
| 24. | -78. | -142. | -124. | -52. | -78. | -63. | -72. | -103. | -151. | -96. |
| 36. | -81. | -171. | -149. | -75. | -89. | -76. | -87. | -127. | -178. | -115. |
| 48. | -96. | -176. | -155. | -83. | -107. | -90. | -100. | -136. | -180. | -125. |
| 60. | -100. | -166. | -149. | -96. | -115. | -94. | -88. | -135. | -174. | -124. |
| 72. | -95. | -144. | -123. | -96. | -111. | -99. | -98. | -124. | -129. | -113. |
| 84. | -89. | -96. | -95. | -87. | -88. | -67. | -80. | -98. | -88. | -88. |
| 96. | -70. | -58. | -65. | -66. | -46. | -60. | -65. | -69. | -51. | -62. |
| 114. | -43. | -17. | -28. | -41. | -48. | -29. | -42. | -28. | 0. | -30. |
| 132. | -22. | 13. | -3. | -16. | -21. | -7. | -18. | -3. | 12. | -7. |
| 156. | -1. | 14. | 6. | -1. | 0. | 4. | -2. | 5. | 13. | 4. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.09 | -.10 | -.13 | -.08 | -.10 | -.08 | -.09 | -.10 | -.11 | -.09 |
| SLOPE | .00212 | .00186 | .00328 | .00172 | .00179 | .00134 | .00173 | .00212 | .00235 | .00263 |
| LOAD | -2.07 | -3.27 | -3.38 | -1.82 | -1.83 | -2.17 | -1.99 | -1.94 | -3.72 | -2.47 |

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*              HOUSTON PILE GROUP STUDY                   *
*  FIELD DATA FROM LATERAL LOAD TEST OF OCT 18, 1984      *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 1
CYCLE NO. 1001
LOAD ON GROUP = 44.31 FROM BIG LOAD CELL, KIPS
= 45.95 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -2.29352 INCHES
WEST CAP DEFL = -2.34147 INCHES

| DEPTH, INCHES | BENDING MOMENTS, INCH-KIPS PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 140. | 101. | 139. | 192. | 114. | 114. | 159. | 91. | 54. | 119. |
| 24. | 189. | 147. | 150. | 255. | 145. | 163. | 197. | 128. | 93. | 163. |
| 36. | 200. | 164. | 178. | 291. | 162. | 183. | 218. | 161. | 128. | 187. |
| 48. | 209. | 180. | 194. | 299. | 205. | 207. | 264. | 178. | 148. | 209. |
| 60. | 219. | 198. | 202. | 293. | 212. | 230. | 260. | 190. | 148. | 217. |
| 72. | 195. | 206. | 203. | 274. | 213. | 224. | 239. | 196. | 169. | 213. |
| 84. | 168. | 193. | 188. | 233. | 197. | 232. | 220. | 189. | 173. | 199. |
| 96. | 142. | 179. | 170. | 189. | 239. | 198. | 176. | 175. | 147. | 180. |
| 114. | 112. | 157. | 134. | 131. | 148. | 175. | 130. | 145. | 145. | 142. |
| 132. | 68. | 127. | 97. | 83. | 119. | 125. | 87. | 106. | 139. | 102. |
| 156. | 29. | 56. | 41. | 39. | 59. | 57. | 39. | 45. | 54. | 47. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .29 | .35 | .29 | .36 | .33 | .36 | .34 | .31 | .33 | .33 |
| SLOPE | -.00349 | -.00357 | -.00294 | -.00534 | -.00320 | -.00372 | -.00372 | -.00322 | -.00299 | -.00354 |
| LOAD | 6.79 | 5.42 | 3.80 | 6.46 | 5.20 | 4.77 | 5.91 | 4.15 | 3.45 | 5.11 |

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* HOUSTON PILE GROUP STUDY *

* FIELD DATA FROM LATERAL LOAD TEST OF OCT 18, 1984 *

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LOAD NO. 1
CYCLE NO. 2050
LOAD ON GROUP = -26.30 FROM BIG LOAD CELL, KIPS
= -24.69 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -2.29370 INCHES
WEST CAP DEFL = -2.34165 INCHES

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -47. | -116. | -101. | -32. | -60. | -46. | -51. | -79. | -115. | -72. |
| 24. | -78. | -159. | -139. | -50. | -82. | -68. | -72. | -110. | -164. | -102. |
| 36. | -80. | -186. | -161. | -71. | -91. | -78. | -83. | -133. | -189. | -119. |
| 48. | -92. | -186. | -163. | -77. | -106. | -90. | -97. | -138. | -187. | -126. |
| 60. | -93. | -171. | -150. | -85. | -111. | -90. | -80. | -134. | -177. | -121. |
| 72. | -85. | -142. | -118. | -83. | -103. | -91. | -86. | -118. | -126. | -106. |
| 84. | -76. | -87. | -85. | -70. | -76. | -54. | -66. | -87. | -80. | -76. |
| 96. | -56. | -53. | -51. | -46. | -8. | -42. | -49. | -53. | -40. | -44. |
| 114. | -26. | 3. | -12. | -19. | -29. | -5. | -23. | -8. | 15. | -12. |
| 132. | -7. | 34. | 15. | 2. | -3. | 15. | -1. | 16. | 27. | 11. |
| 156. | 6. | 27. | 16. | 8. | 11. | 16. | 6. | 15. | 24. | 14. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.06 | -.05 | -.08 | -.05 | -.07 | -.03 | -.05 | -.07 | -.08 | -.06 |
| SLOPE | .00196 | .00205 | .00210 | .00153 | .00162 | .00128 | .00159 | .00201 | .00233 | .00183 |
| LOAD | -2.20 | -3.56 | -4.04 | -2.13 | -1.98 | -2.43 | -2.04 | -2.17 | -4.14 | -2.74 |

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*              HOUSTON PILE GROUP STUDY                *
*  FIELD DATA FROM LATERAL LOAD TEST OF OCT 18, 1984  *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 1
CYCLE NO. 1100
LOAD ON GROUP = 49.48 FROM BIG LOAD CELL, KIPS
= 51.31 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -2.29299 INCHES
WEST CAP DEFL = -2.34165 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 159. | 110. | 121. | 214. | 126. | 126. | 179. | 106. | 61. | 134. |
| 24. | 216. | 163. | 167. | 285. | 162. | 180. | 222. | 147. | 103. | 183. |
| 36. | 230. | 181. | 199. | 324. | 181. | 203. | 246. | 185. | 142. | 210. |
| 48. | 241. | 198. | 218. | 335. | 230. | 233. | 298. | 205. | 165. | 236. |
| 60. | 253. | 220. | 230. | 329. | 240. | 257. | 296. | 220. | 165. | 245. |
| 72. | 228. | 229. | 233. | 311. | 243. | 251. | 275. | 229. | 189. | 243. |
| 84. | 201. | 217. | 220. | 271. | 229. | 264. | 256. | 223. | 196. | 231. |
| 96. | 174. | 205. | 205. | 226. | 281. | 230. | 211. | 210. | 170. | 213. |
| 114. | 143. | 184. | 170. | 164. | 180. | 209. | 163. | 181. | 171. | 174. |
| 132. | 96. | 155. | 131. | 111. | 151. | 155. | 116. | 139. | 133. | 132. |
| 156. | 42. | 74. | 58. | 53. | 78. | 74. | 53. | 62. | 70. | 63. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .37 | .41 | .35 | .43 | .40 | .43 | .41 | .38 | .39 | .40 |
| SLOPE | -.00421 | -.00415 | -.00363 | -.00585 | -.00379 | -.00434 | -.00439 | -.00390 | -.00359 | -.00421 |
| LOAD | 7.50 | 5.51 | 4.03 | 6.92 | 5.80 | 5.33 | 6.66 | 4.73 | 3.83 | 5.70 |

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* HOUSTON PILE GROUP STUDY *

* FIELD DATA FROM LATERAL LOAD TEST OF OCT 18, 1984 *

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LOAD NO. 1
CYCLE NO. 2100
LOAD ON GROUP = -31.21 FROM BIG LOAD CELL, KIPS
= -28.64 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -2.29282 INCHES
WEST CAP DEFL = -2.34147 INCHES

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -48. | -133. | -117. | -36. | -68. | -53. | -55. | -87. | -128. | -81. |
| 24. | -79. | -179. | -156. | -54. | -89. | -76. | -75. | -116. | -179. | -112. |
| 36. | -79. | -205. | -176. | -75. | -96. | -85. | -84. | -140. | -201. | -127. |
| 48. | -88. | -201. | -172. | -76. | -109. | -94. | -98. | -140. | -195. | -130. |
| 60. | -56. | -178. | -153. | -81. | -109. | -89. | -76. | -131. | -180. | -120. |
| 72. | -74. | -142. | -116. | -74. | -57. | -85. | -77. | -109. | -124. | -99. |
| 84. | -63. | -61. | -73. | -55. | -65. | -43. | -53. | -73. | -72. | -64. |
| 96. | -38. | -40. | -33. | -27. | 25. | -25. | -31. | -33. | -27. | -25. |
| 114. | -3. | 21. | 12. | 5. | -9. | 17. | -1. | 18. | 30. | 10. |
| 132. | 17. | 56. | 41. | 25. | 20. | 40. | 21. | 41. | 46. | 34. |
| 156. | 19. | 41. | 31. | 21. | 27. | 31. | 18. | 31. | 38. | 29. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.01 | -.01 | -.04 | .00 | -.02 | .02 | -.01 | -.02 | -.05 | -.02 |
| SLOPE | .00170 | .00209 | .00192 | .00134 | .00153 | .00114 | .00142 | .00183 | .00217 | .00168 |
| LOAD | -2.49 | -3.79 | -4.84 | -2.61 | -2.40 | -2.93 | -2.35 | -2.52 | -4.71 | -3.18 |

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* HOUSTON PILE GROUP STUDY *
* FIELD DATA FROM LATERAL LOAD TEST OF OCT 18, 1984 *
**************************************************

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 2
CYCLE NO. 1[illegible]
LOAD ON GROUP = -71.47 FROM BIG LOAD CELL, KIPS
= -67.[illegible] FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.57402 INCHES
WEST CAP DEFL = -.58566 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -122. | -276. | -264. | -121. | -165. | -145. | -129. | -184. | -244. | -183. |
| 24. | -190. | -381. | -362. | -176. | -219. | -210. | -180. | -257. | -340. | -257. |
| 36. | -207. | -440. | -423. | -226. | -249. | -241. | -220. | -314. | -397. | -302. |
| 48. | -239. | -446. | -434. | -251. | -297. | -278. | -250. | -334. | -402. | -326. |
| 60. | -252. | -426. | -416. | -279. | -310. | -287. | -253. | -338. | -382. | -327. |
| 72. | -253. | -375. | -345. | -284. | -305. | -293. | -274. | -323. | -314. | -307. |
| 84. | -246. | -277. | -283. | -273. | -269. | -249. | -264. | -282. | -246. | -265. |
| 96. | -227. | -222. | -222. | -248. | -179. | -228. | -248. | -239. | -185. | -222. |
| 114. | -160. | -131. | -144. | -197. | -201. | -170. | -200. | -161. | -92. | -164. |
| 132. | -116. | -67. | -77. | -125. | -133. | -107. | -137. | -93. | -65. | -102. |
| 156. | -39. | -16. | -17. | -42. | -55. | -39. | -50. | -27. | -18. | -33. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.38 | -.39 | -.41 | -.39 | -.40 | -.37 | -.40 | -.40 | -.43 | -.40 |
| SLOPE | .00556 | .00633 | .00608 | .00580 | .00533 | .00496 | .00516 | .00585 | .00615 | .00569 |
| LOAD | -5.51 | -9.81 | -10.21 | -5.71 | -6.67 | -7.66 | -5.28 | -6.37 | -9.78 | -7.44 |

HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF OCT 18, 1984

| | | | |
|---|---|---|---|
| NORTH | | | |
| D | G | A | |
| F | E | H | |
| B | I | C | |
| PILE LEGEND | | | |

LOAD NO. 2
CYCLE NO. 2001
LOAD ON GROUP = 91.35 FROM BIG LOAD CELL, KIPS
= 95.46 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .47713 INCHES
WEST CAP DEFL = -.00938 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 307. | 207. | 223. | 391. | 238. | 238. | 348. | 218. | 135. | 256. |
| 24. | 424. | 305. | 315. | 321. | 309. | 349. | 434. | 306. | 218. | 353. |
| 36. | 459. | 348. | 384. | 602. | 349. | 394. | 497. | 385. | 293. | 412. |
| 48. | 509. | 391. | 432. | 627. | 442. | 455. | 592. | 429. | 358. | 468. |
| 60. | 524. | 434. | 461. | 626. | 467. | 500. | 579. | 457. | 339. | 487. |
| 72. | 477. | 455. | 470. | 594. | 468. | 501. | 535. | 470. | 387. | 486. |
| 84. | 428. | 428. | 455. | 521. | 461. | 507. | 491. | 453. | 395. | 460. |
| 96. | 353. | 422. | 433. | 440. | 505. | 446. | 402. | 420. | 348. | 420. |
| 114. | 290. | 358. | 374. | 330. | 366. | 397. | 314. | 361. | 347. | 349. |
| 132. | 203. | 309. | 292. | 233. | 308. | 305. | 249. | 282. | 271. | 272. |
| 156. | 89. | 145. | 133. | 114. | 166. | 149. | 117. | 128. | 151. | 133. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .75 | .79 | .73 | .82 | .80 | .82 | .81 | .77 | .77 | .78 |
| SLOPE | -.00903 | -.00860 | -.00774 | -.01151 | -.00783 | -.00868 | -.00913 | -.00840 | -.00782 | -.00875 |
| LOAD | 13.93 | 11.98 | 7.33 | 13.01 | 10.16 | 10.15 | 12.54 | 8.84 | 7.52 | 10.61 |

**HOUSTON PILE GROUP STUDY**
**FIELD DATA FROM LATERAL LOAD TEST OF OCT 18, 1984**

| | NORTH | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 3
CYCLE NO. 1001
LOAD ON GROUP = -83.89 FROM BIG LOAD CELL, KIPS
= -71.55 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.79295 INCHES
WEST CAP DEFL = -.77895 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -136. | -333. | -322. | -138. | -197. | -174. | -151. | -216. | -289. | -218. |
| 24. | -218. | -485. | -460. | -216. | -271. | -262. | -215. | -311. | -419. | -317. |
| 36. | -249. | -581. | -567. | -277. | -317. | -309. | -278. | -390. | -510. | -386. |
| 48. | -293. | -622. | -604. | -320. | -390. | -369. | -309. | -429. | -536. | -430. |
| 60. | -322. | -612. | -598. | -364. | -418. | -393. | -334. | -453. | -526. | -447. |
| 72. | -334. | -555. | -525. | -379. | -421. | -409. | -370. | -447. | -463. | -434. |
| 84. | -343. | -438. | -439. | -377. | -385. | -362. | -371. | -407. | -380. | -389. |
| 96. | -326. | -349. | -352. | -359. | -281. | -339. | -357. | -360. | -294. | -335. |
| 114. | -275. | -226. | -226. | -303. | -364. | -275. | -302. | -263. | -162. | -259. |
| 132. | -196. | -127. | -125. | -216. | -213. | -185. | -228. | -167. | -112. | -175. |
| 156. | -75. | -22. | -13. | -81. | -93. | -70. | -93. | -48. | -22. | -58. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.58 | -.59 | -.66 | -.59 | -.61 | -.58 | -.60 | -.61 | -.63 | -.60 |
| SLOPE | .00705 | .00848 | .00821 | .00746 | .00692 | .00647 | .00669 | .00751 | .00821 | .00744 |
| LOAD | -6.01 | -7.93 | -11.76 | -5.29 | -7.99 | -8.75 | -6.06 | -7.40 | -9.34 | -7.95 |

# APPENDIX C

Results of the load test of the group of piles,
December 13, 1984

HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

| | | | |
|---|---|---|---|
| | NORTH | | |
| | D | G | A |
| | F | E | H |
| | B | I | C |
| | PILE LEGEND | | |

LOAD NO. 1
CYCLE NO. 1001
LOAD ON GROUP = 31.27 FROM RIG LOAD CELL, KIPS
= 30.11 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .19515 INCHES
WEST CAP DEFL = -.13680 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 69. | 98. | 60. | 82. | 92. | 77. | 67. | 67. | 35. | 72. |
| 24. | 100. | 142. | 83. | 115. | 118. | 110. | 93. | 96. | 62. | 102. |
| 36. | 109. | 158. | 103. | 141. | 128. | 126. | 115. | 121. | 83. | 120. |
| 48. | 123. | 169. | 116. | 158. | 151. | 145. | 133. | 131. | 103. | 137. |
| 60. | 132. | 180. | 129. | 169. | 154. | 163. | 143. | 136. | 111. | 146. |
| 72. | 129. | 176. | 130. | 171. | 148. | 164. | 153. | 136. | 127. | 148. |
| 84. | 118. | 152. | 125. | 161. | 129. | 159. | 149. | 125. | 135. | 139. |
| 96. | 95. | 127. | 108. | 134. | 110. | 136. | 118. | 100. | 105. | 115. |
| 114. | 65. | 92. | 116. | 91. | 80. | 102. | 83. | 70. | 87. | 87. |
| 132. | 26. | 59. | 62. | 59. | 62. | 71. | 54. | 48. | 64. | 56. |
| 156. | 15. | 26. | 25. | 21. | 26. | 26. | 19. | 17. | 24. | 22. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .19 | .24 | .20 | .24 | .22 | .25 | .22 | .19 | .25 | .22 |
| SLOPE | -.00258 | -.00311 | -.00232 | -.00329 | -.00259 | -.00281 | -.00260 | -.00245 | -.00213 | -.00265 |
| LOAD | 3.71 | 3.82 | 2.48 | 3.63 | 4.19 | 3.93 | 3.41 | 3.08 | 1.84 | 3.35 |

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HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 1
CYCLE NO. 2001
LOAD ON GROUP = -32.85 FROM RIG LOAD CELL, KIPS
= -31.41 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.14831 INCHES
WEST CAP DEFL = -.21969 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -52. | -112. | -128. | -80. | -49. | -65. | -66. | -71. | -116. | -83. |
| 24. | -74. | -158. | -175. | -108. | -62. | -98. | -83. | -95. | -177. | -114. |
| 36. | -81. | -182. | -202. | -135. | -72. | -109. | -97. | -113. | -212. | -134. |
| 48. | -94. | -189. | -205. | -144. | -98. | -125. | -113. | -122. | -209. | -144. |
| 60. | -111. | -180. | -192. | -158. | -113. | -135. | -121. | -130. | -191. | -148. |
| 72. | -113. | -167. | -164. | -163. | -126. | -143. | -131. | -133. | -156. | -144. |
| 84. | -114. | -129. | -134. | -155. | -133. | -138. | -132. | -128. | -120. | -132. |
| 96. | -120. | -116. | -113. | -142. | -145. | -137. | -132. | -131. | -84. | -125. |
| 114. | -99. | -80. | -32. | -109. | -134. | -121. | -125. | -106. | -49. | -95. |
| 132. | -81. | -45. | -36. | -60. | -94. | -78. | -86. | -67. | -31. | -65. |
| 156. | -28. | -13. | -9. | -24. | -50. | -34. | -37. | -26. | -18. | -27. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.19 | -.20 | -.19 | -.21 | -.21 | -.22 | -.21 | -.20 | -.20 | -.20 |
| SLOPE | .00240 | .00310 | .00281 | .00307 | .00226 | .00252 | .00245 | .00253 | .00322 | .00271 |
| LOAD | -2.47 | -5.23 | -5.09 | -2.98 | -1.96 | -3.35 | -2.27 | -2.62 | -5.44 | -3.49 |

HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 1
CYCLE NO. 1805
LOAD ON GROUP = 33.40 FROM BIG LOAD CELL, KIPS
= 31.99 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .20462 INCHES
WEST CAP DEFL = .28875 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 71. | 93. | 52. | 72. | 105. | 75. | 72. | 60. | 26. | 70. |
| 24. | 108. | 143. | 78. | 108. | 140. | 113. | 105. | 95. | 51. | 105. |
| 36. | 120. | 162. | 100. | 137. | 155. | 135. | 131. | 126. | 73. | 127. |
| 48. | 137. | 175. | 119. | 156. | 184. | 158. | 154. | 142. | 97. | 147. |
| 60. | 145. | 152. | 133. | 167. | 186. | 178. | 161. | 150. | 110. | 158. |
| 72. | 138. | 186. | 138. | 168. | 176. | 175. | 168. | 150. | 131. | 159. |
| 84. | 127. | 159. | 134. | 157. | 147. | 169. | 157. | 137. | 142. | 148. |
| 96. | 92. | 132. | 113. | 130. | 116. | 141. | 119. | 104. | 111. | 118. |
| 114. | 64. | 93. | 132. | 93. | 72. | 101. | 76. | 69. | 95. | 88. |
| 132. | 25. | 55. | 67. | 62. | 50. | 68. | 47. | 45. | 71. | 54. |
| 156. | 14. | 24. | 29. | 23. | 15. | 24. | 14. | 15. | 26. | 20. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .19 | .24 | .19 | .23 | .22 | .24 | .21 | .20 | .23 | .22 |
| SLOPE | -.00248 | -.00252 | -.00217 | -.00295 | -.00252 | -.00259 | -.00240 | -.00212 | -.00193 | -.00245 |
| LOAD | 4.23 | 4.80 | 2.52 | 3.60 | 4.97 | 4.12 | 3.94 | 3.10 | 1.51 | 3.55 |

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* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
*                  HOUSTON PILE GROUP STUDY                         *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984                *
* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
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LOAD NO. 1
CYCLE NO. 2605
LOAD ON GROUP = -32.92 FROM BIG LOAD CELL, KIPS
= -30.63 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.11449 INCHES
WEST CAP DEFL = -.16131 INCHES

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -40. | -92. | -109. | -70. | -22. | -52. | -53. | -58. | -112. | -68. |
| 24. | -63. | -134. | -153. | -99. | -34. | -80. | -71. | -79. | -175. | -99. |
| 36. | -71. | -155. | -184. | -127. | -46. | -94. | -88. | -100. | -213. | -120. |
| 48. | -86. | -169. | -188. | -139. | -73. | -113. | -106. | -110. | -211. | -133. |
| 60. | -105. | -162. | -179. | -153. | -93. | -125. | -114. | -119. | -189. | -138. |
| 72. | -108. | -152. | -150. | -159. | -110. | -133. | -125. | -124. | -149. | -135. |
| 84. | -110. | -120. | -120. | -150. | -121. | -130. | -126. | -121. | -112. | -123. |
| 96. | -118. | -110. | -104. | -135. | -140. | -131. | -128. | -126. | -75. | -115. |
| 114. | -93. | -78. | -23. | -98. | -133. | -116. | -119. | -101. | -40. | -89. |
| 132. | -75. | -51. | -28. | -49. | -96. | -72. | -80. | -64. | -22. | -60. |
| 156. | -24. | -15. | -2. | -19. | -50. | -31. | -34. | -25. | -13. | -24. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.18 | -.19 | -.17 | -.19 | -.20 | -.20 | -.20 | -.18 | -.18 | -.19 |
| SLOPE | .00228 | .00267 | .00252 | .00270 | .00182 | .00216 | .00206 | .00216 | .00284 | .00235 |
| LOAD | -2.55 | -5.13 | -5.13 | -3.07 | -1.49 | -3.13 | -2.19 | -2.33 | -5.61 | -3.40 |

*******************************************************
*                HOUSTON PILE GROUP STUDY                *
* FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *
*******************************************************

LOAD NO. 1
CYCLE NO. 1010
LOAD ON GROUP = 35.05 FROM BIG LOAD CELL, KIPS
= 34.06 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .17477 INCHES
WEST CAP DEFL = .28771 INCHES

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 94. | 108. | 62. | 99. | 126. | 92. | 102. | 74. | 31. | 88. |
| 24. | 137. | 161. | 89. | 140. | 164. | 137. | 141. | 114. | 60. | 127. |
| 36. | 150. | 185. | 115. | 173. | 183. | 163. | 166. | 150. | 87. | 152. |
| 48. | 163. | 200. | 134. | 187. | 219. | 188. | 198. | 166. | 112. | 174. |
| 60. | 165. | 217. | 147. | 188. | 218. | 207. | 190. | 170. | 123. | 180. |
| 72. | 146. | 207. | 147. | 175. | 202. | 197. | 187. | 163. | 142. | 174. |
| 84. | 125. | 173. | 139. | 150. | 162. | 180. | 161. | 141. | 149. | 153. |
| 96. | 79. | 137. | 110. | 115. | 119. | 141. | 109. | 97. | 112. | 113. |
| 114. | 46. | 85. | 129. | 75. | 58. | 88. | 55. | 52. | 89. | 75. |
| 132. | 8. | 41. | 53. | 50. | 32. | 54. | 28. | 28. | 65. | 40. |
| 156. | 6. | 16. | 24. | 19. | 1. | 15. | 5. | 6. | 22. | 13. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .18 | .23 | .17 | .22 | .21 | .23 | .20 | .18 | .23 | .21 |
| SLOPE | -.00227 | -.00284 | -.00200 | -.00294 | -.00253 | -.00269 | -.00252 | -.00215 | -.00193 | -.00243 |
| LOAD | 4.73 | 4.15 | 2.44 | 3.87 | 5.32 | 4.33 | 4.52 | 3.27 | 1.44 | 3.78 |

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* HOUSTON PILE GROUP STUDY *

* FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *

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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 1
CYCLE NO. 2010
LOAD ON GROUP = -27.88 FROM BIG LOAD CELL, KIPS
= -26.38 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.12479 INCHES
WEST CAP DEFL = -.16212 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -38. | -79. | -100. | -69. | -14. | -46. | -50. | -55. | -109. | -62. |
| 24. | -59. | -116. | -141. | -97. | -24. | -72. | -67. | -75. | -171. | -91. |
| 36. | -68. | -140. | -171. | -126. | -35. | -85. | -83. | -93. | -209. | -112. |
| 48. | -83. | -152. | -176. | -138. | -60. | -105. | -100. | -104. | -208. | -12[illegible]. |
| 60. | -103. | -147. | -169. | -153. | -82. | -117. | -109. | -115. | -189. | -132. |
| 72. | -107. | -143. | -145. | -159. | -101. | -128. | -119. | -121. | -151. | -130. |
| 84. | -108. | -116. | -118. | -150. | -116. | -128. | -122. | -119. | -114. | -121. |
| 96. | -120. | -112. | -105. | -137. | -139. | -132. | -127. | -127. | -78. | -120. |
| 114. | -97. | -85. | -22. | -101. | -139. | -120. | -122. | -107. | -43. | -93. |
| 132. | -81. | -62. | -35. | -51. | -104. | -77. | -85. | -69. | -24. | -65. |
| 156. | -27. | -20. | -6. | -20. | -57. | -35. | -38. | -28. | -14. | -27. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.19 | -.19 | -.17 | -.20 | -.20 | -.20 | -.20 | -.19 | -.18 | -.19 |
| SLOPE | .00215 | .00254 | .00244 | .00271 | .00176 | .00212 | .00206 | .00217 | .00292 | .00232 |
| LOAD | -2.24 | -4.26 | -4.48 | -2.85 | -.91 | -2.60 | -1.92 | -1.88 | -5.23 | -2.93 |

HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 1
CYCLE NO. 1020
LOAD ON GROUP = 39.65 FROM BIG LOAD CELL, KIPS
= 37.96 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .17418 INCHES
WEST CAP DEFL = .28990 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 105. | 116. | 67. | 109. | 134. | 100. | 115. | 81. | 35. | 96. |
| 24. | 152. | 175. | 97. | 156. | 175. | 146. | 156. | 121. | 64. | 138. |
| 36. | 160. | 194. | 118. | 182. | 191. | 167. | 175. | 155. | 88. | 159. |
| 48. | 169. | 204. | 134. | 191. | 224. | 190. | 207. | 168. | 111. | 178. |
| 60. | 166. | 219. | 143. | 187. | 221. | 206. | 194. | 168. | 119. | 180. |
| 72. | 143. | 207. | 141. | 170. | 200. | 192. | 185. | 158. | 135. | 170. |
| 84. | 119. | 170. | 130. | 141. | 157. | 173. | 154. | 133. | 141. | 147. |
| 96. | 68. | 128. | 98. | 101. | 111. | 130. | 97. | 87. | 101. | 102. |
| 114. | 35. | 77. | 45. | 64. | 46. | 78. | 43. | 40. | 80. | 56. |
| 132. | 9. | 32. | 45. | 46. | 23. | 47. | 19. | 22. | 59. | 34. |
| 156. | 2. | 12. | 23. | 18. | -6. | 11. | 0. | 3. | 19. | 9. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .17 | .23 | .17 | .22 | .20 | .23 | .20 | .17 | .23 | .20 |
| SLOPE | -.00233 | -.00289 | -.00196 | -.00298 | -.00257 | -.00273 | -.00257 | -.00217 | -.00183 | -.00245 |
| LOAD | 5.35 | 4.63 | 2.75 | 4.45 | 5.83 | 4.76 | 5.04 | 3.55 | 1.60 | 4.22 |

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*              HOUSTON PILE GROUP STUDY            *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 1
CYCLE NO. 2020
LOAD ON GROUP = -26.83 FROM BIG LOAD CELL, KIPS
= -26.93 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.11858 INCHES
WEST CAP DEFL = -.15252 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -49. | -100. | -122. | -84. | -31. | -65. | -64. | -72. | -130. | -79. |
| 24. | -75. | -140. | -166. | -113. | -41. | -94. | -81. | -94. | -193. | -111. |
| 36. | -82. | -160. | -191. | -143. | -50. | -105. | -95. | -110. | -229. | -129. |
| 48. | -95. | -165. | -190. | -151. | -73. | -122. | -113. | -117. | -221. | -138. |
| 60. | -112. | -154. | -175. | -164. | -91. | -129. | -117. | -124. | -196. | -140. |
| 72. | -113. | -144. | -147. | -166. | -107. | -137. | -126. | -125. | -155. | -135. |
| 84. | -111. | -114. | -118. | -155. | -118. | -133. | -125. | -120. | -113. | -123. |
| 96. | -123. | -111. | -106. | -140. | -142. | -134. | -131. | -127. | -79. | -121. |
| 114. | -99. | -85. | -108. | -101. | -141. | -119. | -124. | -108. | -44. | -103. |
| 132. | -79. | -63. | -35. | -48. | -103. | -74. | -85. | -68. | -23. | -64. |
| 156. | -27. | -20. | -3. | -18. | -59. | -34. | -39. | -28. | -15. | -27. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.18 | -.18 | -.17 | -.19 | -.19 | -.20 | -.20 | -.19 | -.18 | -.19 |
| SLOPE | .00227 | .00277 | .00257 | .00293 | .00201 | .00228 | .00230 | .00238 | .00322 | .00253 |
| LOAD | -2.17 | -4.21 | -4.40 | -2.88 | -.94 | -2.72 | -2.02 | -2.05 | -5.54 | -2.99 |

HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

LOAD NO. 1
CYCLE NO. 1050
LOAD ON GROUP = 43.98 FROM BIG LOAD CELL, KIPS
= 42.92 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .16388 INCHES
WEST CAP DEFL = .29257 INCHES

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 111. | 118. | 69. | 117. | 141. | 105. | 127. | 86. | 38. | 101. |
| 24. | 164. | 179. | 102. | 170. | 186. | 156. | 172. | 130. | 69. | 148. |
| 36. | 173. | 201. | 125. | 198. | 204. | 179. | 192. | 165. | 95. | 170. |
| 48. | 181. | 214. | 142. | 205. | 239. | 202. | 228. | 177. | 120. | 190. |
| 60. | 174. | 229. | 150. | 197. | 234. | 218. | 208. | 176. | 127. | 191. |
| 72. | 147. | 215. | 147. | 175. | 211. | 200. | 194. | 163. | 143. | 177. |
| 84. | 120. | 175. | 135. | 141. | 165. | 179. | 157. | 135. | 147. | 150. |
| 96. | 65. | 130. | 98. | 98. | 114. | 132. | 96. | 87. | 105. | 103. |
| 114. | 31. | 76. | 16. | 61. | 45. | 78. | 38. | 38. | 81. | 51. |
| 132. | 4. | 29. | 44. | 44. | 21. | 48. | 17. | 20. | 61. | 32. |
| 156. | 1. | 10. | 24. | 17. | -7. | 12. | 0. | 2. | 20. | 9. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .16 | .23 | .17 | .22 | .20 | .23 | .19 | .17 | .23 | .20 |
| SLOPE | -.00261 | -.00316 | -.00205 | -.00318 | -.00271 | -.00282 | -.00267 | -.00218 | -.00179 | -.00257 |
| LOAD | 6.01 | 5.12 | 3.07 | 5.15 | 6.39 | 5.30 | 5.83 | 4.02 | 2.02 | 4.77 |

HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 1
CYCLE NO. 2050
LOAD ON GROUP = -32.78 FROM BIG LOAD CELL, KIPS
= -31.22 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.10969 INCHES
WEST CAP DEFL = -.14096 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -43. | -91. | -111. | -73. | -19. | -53. | -51. | -62. | -119. | -69. |
| 24. | -62. | -125. | -148. | -95. | -23. | -75. | -64. | -78. | -180. | -94. |
| 36. | -68. | -145. | -175. | -126. | -33. | -85. | -80. | -97. | -219. | -115. |
| 48. | -83. | -153. | -178. | -137. | -58. | -109. | -97. | -108. | -214. | -126. |
| 60. | -102. | -143. | -167. | -151. | -79. | -115. | -104. | -116. | -189. | -130. |
| 72. | -104. | -134. | -139. | -155. | -96. | -127. | -114. | -119. | -146. | -126. |
| 84. | -104. | -105. | -109. | -144. | -108. | -123. | -115. | -114. | -105. | -114. |
| 96. | -118. | -103. | -101. | -131. | -128. | -126. | -123. | -121. | -73. | -114. |
| 114. | -95. | -78. | -97. | -94. | -135. | -110. | -119. | -103. | -38. | -97. |
| 132. | -69. | -59. | -30. | -42. | -98. | -65. | -80. | -63. | -17. | -58. |
| 156. | -25. | -19. | 1. | -15. | -56. | -29. | -37. | -27. | -11. | -24. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.18 | -.18 | -.17 | -.19 | -.20 | -.20 | -.20 | -.19 | -.17 | -.19 |
| SLOPE | .00231 | .00269 | .00263 | .00273 | .00179 | .00213 | .00206 | .00226 | .00309 | .00241 |
| LOAD | -2.66 | -4.54 | -5.12 | -3.23 | -1.35 | -3.22 | -2.27 | -2.39 | -6.06 | -3.47 |

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*              HOUSTON PILE GROUP STUDY              *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 1
CYCLE NO. 1100
LOAD ON GROUP = 43.71 FROM BIG LOAD CELL, KIPS
= 42.47 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .14901 INCHES
WEST CAP DEFL = .29382 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 118. | 123. | 71. | 125. | 145. | 109. | 135. | 89. | 38. | 106. |
| 24. | 170. | 183. | 101. | 177. | 189. | 158. | 178. | 130. | 68. | 151. |
| 36. | 177. | 203. | 121. | 201. | 204. | 178. | 195. | 164. | 92. | 170. |
| 48. | 182. | 212. | 135. | 204. | 237. | 199. | 230. | 174. | 115. | 188. |
| 60. | 172. | 227. | 142. | 194. | 231. | 213. | 206. | 170. | 121. | 186. |
| 72. | 142. | 210. | 137. | 170. | 205. | 194. | 190. | 156. | 134. | 171. |
| 84. | 113. | 169. | 123. | 133. | 157. | 171. | 152. | 127. | 139. | 143. |
| 96. | 56. | 122. | 86. | 89. | 102. | 124. | 88. | 79. | 98. | 94. |
| 114. | 22. | 69. | -47. | 53. | 37. | 71. | 31. | 29. | 74. | 38. |
| 132. | -14. | 24. | 40. | 42. | 16. | 46. | 11. | 17. | 58. | 27. |
| 156. | -2. | 5. | 23. | 17. | -10. | 10. | -4. | 0. | 19. | 7. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .15 | .23 | .16 | .21 | .20 | .23 | .19 | .16 | .22 | .19 |
| SLOPE | -.00249 | -.00302 | -.00193 | -.00315 | -.00270 | -.00283 | -.00277 | -.00229 | -.00185 | -.00256 |
| LOAD | 6.04 | 5.09 | 2.97 | 5.08 | 6.38 | 5.25 | 5.83 | 3.95 | 1.89 | 4.72 |

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HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

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LOAD NO. 1
CYCLE NO. 2100
LOAD ON GROUP = -32.98 FROM BIG LOAD CELL, KIPS
= -31.64 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.10617 INCHES
WEST CAP DEFL = -.12917 INCHES

| | NORTH | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -45. | -93. | -115. | -74. | -21. | -56. | -52. | -64. | -124. | -72. |
| 24. | -65. | -125. | -156. | -99. | -29. | -83. | -67. | -87. | -188. | -100. |
| 36. | -72. | -151. | -184. | -130. | -39. | -97. | -82. | -104. | -226. | -120. |
| 48. | -85. | -156. | -183. | -138. | -62. | -114. | -98. | -112. | -217. | -129. |
| 60. | -103. | -142. | -168. | -150. | -80. | -120. | -102. | -118. | -190. | -130. |
| 72. | -103. | -129. | -138. | -151. | -94. | -126. | -110. | -118. | -145. | -124. |
| 84. | -101. | -95. | -108. | -139. | -105. | -119. | -110. | -111. | -101. | -110. |
| 96. | -118. | -95. | -101. | -127. | -133. | -122. | -120. | -119. | -70. | -112. |
| 114. | -95. | -75. | -169. | -90. | -133. | -104. | -117. | -102. | -37. | -102. |
| 132. | -81. | -56. | -28. | -36. | -94. | -58. | -78. | -60. | -14. | -56. |
| 156. | -25. | -16. | 1. | -13. | -54. | -26. | -36. | -25. | -9. | -23. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.18 | -.17 | -.17 | -.18 | -.19 | -.19 | -.19 | -.19 | -.16 | -.18 |
| SLOPE | .00229 | .00263 | .00259 | .00267 | .00179 | .00209 | .00202 | .00228 | .00306 | .00238 |
| LOAD | -2.69 | -4.94 | -5.16 | -3.21 | -1.39 | -3.30 | -2.29 | -2.49 | -6.17 | -3.52 |

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*              HOUSTON PILE GROUP STUDY          *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *
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|---|---|---|
| NORTH | | |
| D | G | A |
| F | E | H |
| B | I | C |
| PILE LEGEND | | |

LOAD NO. 2
CYCLE NO. 1001
LOAD ON GROUP = 65.81 FROM BIG LOAD CELL, KIPS
= 66.08 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .28326 INCHES
WEST CAP DEFL = .47461 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 197. | 186. | 128. | 227. | 212. | 179. | 230. | 150. | 80. | 176. |
| 24. | 276. | 273. | 179. | 311. | 273. | 258. | 294. | 213. | 136. | 246. |
| 36. | 286. | 305. | 216. | 348. | 296. | 287. | 316. | 263. | 176. | 277. |
| 48. | 299. | 324. | 240. | 349. | 348. | 320. | 373. | 279. | 212. | 305. |
| 60. | 284. | 347. | 252. | 332. | 345. | 339. | 331. | 277. | 212. | 302. |
| 72. | 241. | 333. | 248. | 296. | 321. | 315. | 306. | 261. | 236. | 284. |
| 84. | 200. | 279. | 229. | 240. | 261. | 285. | 252. | 223. | 237. | 245. |
| 96. | 123. | 225. | 181. | 175. | 198. | 219. | 164. | 158. | 179. | 180. |
| 114. | 72. | 145. | 55. | 115. | 112. | 149. | 89. | 95. | 146. | 109. |
| 132. | 33. | 80. | 95. | 84. | 76. | 102. | 56. | 63. | 109. | 78. |
| 156. | 14. | 32. | 42. | 35. | 19. | 35. | 18. | 19. | 41. | 28. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .29 | .40 | .31 | .38 | .36 | .39 | .35 | .30 | .40 | .35 |
| SLOPE | -.00458 | -.00533 | -.00382 | -.00585 | -.00475 | -.00504 | -.00501 | -.00426 | -.00375 | -.00471 |
| LOAD | 9.24 | 7.40 | 4.82 | 8.53 | 8.86 | 8.85 | 9.16 | 6.12 | 3.90 | 7.34 |

HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 2
CYCLE NO. 2001
LOAD ON GROUP = -64.98 FROM BIG LOAD CELL, KIPS
= -63.47 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.41985 INCHES
WEST CAP DEFL = -.34048 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -121. | -213. | -281. | -138. | -117. | -134. | -124. | -166. | -242. | -171. |
| 24. | -179. | -305. | -391. | -189. | -153. | -195. | -163. | -228. | -344. | -239. |
| 36. | -199. | -345. | -461. | -239. | -177. | -218. | -198. | -277. | -416. | -281. |
| 48. | -229. | -354. | -468. | -259. | -229. | -251. | -227. | -299. | -407. | -303. |
| 60. | -263. | -328. | -441. | -285. | -253. | -266. | -247. | -314. | -376. | -308. |
| 72. | -267. | -295. | -375. | -293. | -266. | -272. | -266. | -316. | -306. | -295. |
| 84. | -262. | -230. | -309. | -284. | -266. | -261. | -273. | -300. | -239. | -267. |
| 96. | -279. | -211. | -270. | -270. | -289. | -253. | -282. | -301. | -186. | -260. |
| 114. | -236. | -159. | -296. | -216. | -269. | -219. | -261. | -250. | -116. | -225. |
| 132. | -194. | -117. | -109. | -128. | -197. | -142. | -194. | -167. | -78. | -147. |
| 156. | -77. | -42. | -26. | -52. | -110. | -65. | -84. | -69. | -41. | -63. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.48 | -.40 | -.48 | -.41 | -.46 | -.41 | -.46 | -.50 | -.43 | -.45 |
| SLOPE | .00560 | .00547 | .00630 | .00554 | .00476 | .00470 | .00500 | .00584 | .00653 | .00553 |
| LOAD | -5.69 | -9.24 | -10.97 | -5.26 | -4.70 | -6.25 | -4.56 | -5.99 | -10.82 | -7.05 |

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*              HOUSTON PILE GROUP STUDY             *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *
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| NORTH | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 2
CYCLE NO. 1005
LOAD ON GROUP = 58.92 FROM BIG LOAD CELL, KIPS
= 55.49 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .27234 INCHES
WEST CAP DEFL = .50055 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 189. | 164. | 114. | 207. | 194. | 159. | 215. | 134. | 68. | 161. |
| 24. | 274. | 248. | 162. | 293. | 254. | 233. | 283. | 196. | 119. | 229. |
| 36. | 295. | 282. | 200. | 343. | 281. | 269. | 322. | 251. | 161. | 267. |
| 48. | 319. | 305. | 229. | 358. | 339. | 309. | 383. | 275. | 200. | 302. |
| 60. | 313. | 333. | 246. | 351. | 344. | 337. | 354. | 280. | 204. | 307. |
| 72. | 269. | 325. | 245. | 318. | 326. | 318. | 332. | 269. | 227. | 292. |
| 84. | 222. | 277. | 227. | 259. | 270. | 292. | 273. | 232. | 235. | 254. |
| 96. | 127. | 225. | 177. | 182. | 198. | 225. | 170. | 160. | 178. | 182. |
| 114. | 60. | 152. | 19. | 109. | 111. | 152. | 79. | 88. | 143. | 101. |
| 132. | -5. | 80. | 88. | 71. | 70. | 101. | 35. | 48. | 108. | 66. |
| 156. | -7. | 33. | 47. | 27. | 9. | 32. | 2. | 7. | 39. | 21. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .29 | .40 | .29 | .38 | .36 | .40 | .34 | .30 | .38 | .35 |
| SLOPE | -.00424 | -.00486 | -.00347 | -.00551 | -.00433 | -.00468 | -.00471 | -.00381 | -.00359 | -.00435 |
| LOAD | 8.78 | 6.44 | 4.19 | 7.75 | 8.08 | 7.15 | 8.56 | 5.45 | 3.09 | 6.61 |

HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 2
CYCLE NO. 2005
LOAD ON GROUP = -58.45 FROM RIG LOAD CELL, KIPS
= -55.23 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.41057 INCHES
WEST CAP DEFL = -.32925 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -98. | -180. | -234. | -117. | -85. | -109. | -104. | -136. | -212. | -142. |
| 24. | -151. | -261. | -334. | -164. | -117. | -164. | -139. | -191. | -308. | -203. |
| 36. | -171. | -305. | -405. | -212. | -141. | -186. | -173. | -238. | -381. | -246. |
| 48. | -199. | -323. | -424. | -232. | -194. | -222. | -199. | -265. | -383. | -271. |
| 60. | -236. | -310. | -414. | -260. | -226. | -242. | -223. | -290. | -367. | -285. |
| 72. | -246. | -298. | -363. | -273. | -248. | -255. | -246. | -301. | -307. | -281. |
| 84. | -247. | -231. | -305. | -268. | -255. | -252. | -257. | -291. | -244. | -261. |
| 96. | -272. | -213. | -272. | -260. | -286. | -249. | -273. | -300. | -191. | -257. |
| 114. | -234. | -158. | -302. | -211. | -269. | -218. | -257. | -252. | -118. | -224. |
| 132. | -197. | -116. | -111. | -127. | -199. | -142. | -194. | -171. | -77. | -148. |
| 156. | -82. | -40. | -22. | -52. | -113. | -66. | -88. | -72. | -39. | -64. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.48 | -.38 | -.47 | -.39 | -.45 | -.40 | -.45 | -.49 | -.42 | -.44 |
| SLOPE | .00508 | .00451 | .00580 | .00500 | .00423 | .00429 | .00453 | .00542 | .00598 | .00503 |
| LOAD | -5.21 | -8.22 | -9.68 | -4.78 | -3.73 | -5.31 | -3.96 | -4.92 | -9.41 | -6.14 |

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*                 HOUSTON PILE GROUP STUDY                  *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984        *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 2
CYCLE NO. 1010
LOAD ON GROUP = 63.05 FROM BIG LOAD CELL, KIPS
= 63.38 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .26730 INCHES
WEST CAP DEFL = .50387 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 202. | 171. | 122. | 220. | 203. | 168. | 228. | 143. | 73. | 170. |
| 24. | 290. | 258. | 173. | 305. | 266. | 245. | 299. | 207. | 126. | 241. |
| 36. | 311. | 290. | 210. | 358. | 291. | 278. | 336. | 262. | 168. | 278. |
| 48. | 334. | 312. | 238. | 372. | 350. | 317. | 399. | 285. | 206. | 313. |
| 60. | 327. | 339. | 253. | 364. | 354. | 345. | 368. | 288. | 208. | 316. |
| 72. | 280. | 331. | 250. | 329. | 335. | 325. | 344. | 276. | 231. | 300. |
| 84. | 230. | 282. | 231. | 269. | 277. | 299. | 283. | 238. | 240. | 261. |
| 96. | 132. | 231. | 180. | 188. | 204. | 231. | 175. | 164. | 182. | 187. |
| 114. | 59. | 156. | 21. | 111. | 113. | 157. | 78. | 87. | 146. | 103. |
| 132. | -10. | 84. | 87. | 72. | 70. | 104. | 32. | 46. | 110. | 66. |
| 156. | -11. | 34. | 44. | 27. | 8. | 33. | -2. | 5. | 40. | 20. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .28 | .41 | .29 | .39 | .36 | .41 | .35 | .29 | .38 | .35 |
| SLOPE | -.00454 | -.00514 | -.00364 | -.00584 | -.00453 | -.00453 | -.00499 | -.00408 | -.00377 | -.00461 |
| LOAD | 9.39 | 6.79 | 4.52 | 8.27 | 8.50 | 7.57 | 9.11 | 5.83 | 3.40 | 7.04 |

**HOUSTON PILE GROUP STUDY**

**FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984**

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | I | H |
| P | I | C |

PILE LEGEND

LOAD NO. 2
CYCLE NO. 2010
LOAD ON GROUP = -58.67 FROM BIG LOAD CELL, KIPS
= -56.06 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.40729 INCHES
WEST CAP DEFL = -.32670 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -97. | -182. | -234. | -117. | -85. | -109. | -104. | -136. | -212. | -142. |
| 24. | -150. | -265. | -334. | -163. | -118. | -165. | -138. | -191. | -309. | -204. |
| 36. | -170. | -310. | -407. | -212. | -142. | -188. | -173. | -238. | -384. | -247. |
| 48. | -199. | -328. | -426. | -232. | -195. | -224. | -199. | -266. | -387. | -273. |
| 60. | -235. | -315. | -416. | -259. | -226. | -242. | -221. | -288. | -369. | -286. |
| 72. | -243. | -293. | -363. | -270. | -246. | -253. | -241. | -298. | -310. | -280. |
| 84. | -243. | -234. | -304. | -264. | -252. | -249. | -252. | -289. | -246. | -259. |
| 96. | -268. | -213. | -271. | -257. | -283. | -246. | -269. | -298. | -190. | -255. |
| 114. | -232. | -156. | -378. | -209. | -267. | -215. | -256. | -252. | -117. | -231. |
| 132. | -198. | -114. | -111. | -125. | -198. | -139. | -195. | -172. | -74. | -147. |
| 156. | -84. | -39. | -23. | -51. | -113. | -64. | -89. | -73. | -37. | -64. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.48 | -.38 | -.47 | -.39 | -.45 | -.40 | -.45 | -.49 | -.42 | -.44 |
| SLOPE | .00523 | .00544 | .00590 | .00499 | .00425 | .00427 | .00453 | .00542 | .00601 | .00527 |
| LOAD | -5.19 | -8.29 | -9.77 | -4.85 | -3.83 | -5.43 | -4.05 | -5.07 | -9.57 | -6.23 |

HOUSTON PILE GROUP STUDY
FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 2
CYCLE NO. 1020
LOAD ON GROUP = 64.38 FROM BIG LOAD CELL, KIPS
= 63.31 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .22072 INCHES
WEST CAP DEFL = .53553 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 195. | 175. | 114. | 225. | 205. | 175. | 229. | 138. | 74. | 176. |
| 24. | 282. | 265. | 161. | 318. | 267. | 255. | 300. | 198. | 127. | 242. |
| 36. | 302. | 300. | 193. | 371. | 292. | 290. | 339. | 250. | 169. | 278. |
| 48. | 323. | 324. | 216. | 389. | 350. | 331. | 401. | 270. | 206. | 312. |
| 60. | 313. | 355. | 228. | 384. | 354. | 362. | 373. | 271. | 209. | 317. |
| 72. | 264. | 349. | 222. | 352. | 335. | 346. | 348. | 256. | 230. | 300. |
| 84. | 210. | 300. | 200. | 291. | 275. | 320. | 284. | 214. | 238. | 259. |
| 96. | 109. | 247. | 145. | 208. | 198. | 251. | 172. | 134. | 178. | 183. |
| 114. | 31. | 172. | -20. | 129. | 105. | 178. | 71. | 53. | 139. | 95. |
| 132. | -40. | 98. | 55. | 87. | 63. | 124. | 24. | 16. | 107. | 59. |
| 156. | -30. | 40. | 26. | 35. | 3. | 44. | -5. | -10. | 39. | 16. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .22 | .44 | .23 | .42 | .35 | .44 | .33 | .22 | .38 | .34 |
| SLOPE | -.00403 | -.00549 | -.00301 | -.00617 | -.00443 | -.00527 | -.00491 | -.00356 | -.00341 | -.00448 |
| LOAD | 9.16 | 7.22 | 4.34 | 8.44 | 8.58 | 7.79 | 8.92 | 5.55 | 3.38 | 7.03 |

HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 2
CYCLE NO. 2620
LOAD ON GROUP = -57.97 FROM BIG LOAD CELL, KIPS
= -55.58 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.47480 INCHES
WEST CAP DEFL = -.27202 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -106. | -171. | -253. | -107. | -85. | -95. | -103. | -146. | -212. | -142. |
| 24. | -165. | -248. | -363. | -149. | -119. | -151. | -137. | -208. | -310. | -205. |
| 36. | -188. | -288. | -446. | -194. | -144. | -171. | -174. | -261. | -387. | -250. |
| 48. | -220. | -306. | -473. | -211. | -199. | -204. | -199. | -294. | -391. | -277. |
| 60. | -261. | -288. | -465. | -235. | -231. | -218. | -221. | -321. | -376. | -291. |
| 72. | -271. | -265. | -412. | -243. | -252. | -226. | -243. | -335. | -316. | -285. |
| 84. | -274. | -207. | -353. | -236. | -259. | -221. | -255. | -328. | -252. | -265. |
| 96. | -302. | -188. | -317. | -229. | -290. | -217. | -273. | -338. | -195. | -261. |
| 114. | -267. | -133. | -342. | -181. | -274. | -184. | -260. | -291. | -120. | -228. |
| 132. | -230. | -94. | -142. | -100. | -201. | -110. | -198. | -204. | -73. | -153. |
| 156. | -102. | -30. | -39. | -39. | -116. | -49. | -91. | -88. | -36. | -66. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.56 | -.33 | -.55 | -.34 | -.47 | -.34 | -.46 | -.58 | -.42 | -.45 |
| SLOPE | .00583 | .00439 | .00658 | .00445 | .00434 | .00379 | .00463 | .00608 | .00641 | .00517 |
| LOAD | -5.59 | -7.60 | -10.34 | -4.38 | -3.80 | -4.91 | -3.99 | -5.42 | -9.54 | -6.18 |

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* HOUSTON PILE GROUP STUDY *

* FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *

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LOAD NO. 2
CYCLE NO. 1050
LOAD ON GROUP = 63.92 FROM RIG LOAD CELL, KIPS
= 64.73 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .15916 INCHES
WEST CAP DEFL = .53682 INCHES

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE H | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 210. | 175. | 123. | 234. | 214. | 180. | 245. | 147. | 77. | 178. |
| 24. | 302. | 267. | 172. | 329. | 278. | 261. | 319. | 211. | 131. | 252. |
| 36. | 323. | 302. | 206. | 381. | 303. | 296. | 356. | 265. | 174. | 289. |
| 48. | 343. | 325. | 230. | 398. | 363. | 337. | 422. | 284. | 212. | 324. |
| 60. | 331. | 355. | 239. | 391. | 365. | 366. | 385. | 282. | 213. | 325. |
| 72. | 277. | 349. | 231. | 356. | 343. | 350. | 356. | 262. | 234. | 306. |
| 84. | 216. | 290. | 205. | 293. | 280. | 322. | 288. | 216. | 240. | 262. |
| 96. | 111. | 247. | 145. | 210. | 204. | 253. | 172. | 132. | 179. | 184. |
| 114. | 24. | 175. | 19. | 132. | 104. | 181. | 67. | 47. | 140. | 99. |
| 132. | -32. | 101. | 48. | 91. | 60. | 128. | 18. | 6. | 107. | 59. |
| 156. | -40. | 42. | 20. | 38. | 1. | 47. | -10. | -16. | 39. | 13. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .21 | .45 | .22 | .43 | .35 | .45 | .33 | .21 | .38 | .34 |
| SLOPE | -.00402 | -.00549 | -.00305 | -.00619 | -.00443 | -.00524 | -.00497 | -.00357 | -.00346 | -.00449 |
| LOAD | 9.49 | 7.15 | 4.39 | 8.54 | 8.72 | 7.83 | 9.30 | 5.82 | 3.50 | 7.19 |

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* HOUSTON PILE GROUP STUDY *

* FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *

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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 2
CYCLE NO. 2050
LOAD ON GROUP = -55.86 FROM BIG LOAD CELL, KIPS
= -53.73 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.49305 INCHES
WEST CAP DEFL = -.25816 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -106. | -176. | -250. | -106. | -85. | -100. | -102. | -147. | -214. | -143. |
| 24. | -163. | -254. | -360. | -147. | -119. | -152. | -136. | -209. | -312. | -206. |
| 36. | -186. | -295. | -443. | -192. | -144. | -171. | -171. | -263. | -390. | -251. |
| 48. | -218. | -311. | -470. | -208. | -200. | -205. | -199. | -298. | -396. | -278. |
| 60. | -260. | -295. | -466. | -233. | -233. | -220. | -222. | -328. | -380. | -293. |
| 72. | -272. | -269. | -413. | -241. | -254. | -226. | -243. | -341. | -319. | -286. |
| 84. | -276. | -208. | -352. | -232. | -258. | -218. | -254. | -332. | -252. | -265. |
| 96. | -300. | -183. | -316. | -220. | -289. | -211. | -270. | -338. | -191. | -258. |
| 114. | -267. | -123. | -340. | -168. | -269. | -172. | -255. | -290. | -114. | -222. |
| 132. | -232. | -83. | -143. | -89. | -196. | -98. | -195. | -205. | -68. | -145. |
| 156. | -106. | -25. | -39. | -33. | -113. | -42. | -91. | -89. | -32. | -63. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.56 | -.32 | -.56 | -.32 | -.46 | -.32 | -.46 | -.58 | -.42 | -.44 |
| SLOPE | .00589 | .00434 | .00664 | .00439 | .00439 | .00379 | .00463 | .00621 | .00639 | .00519 |
| LOAD | -5.34 | -7.39 | -9.91 | -4.24 | -3.63 | -4.75 | -3.81 | -5.27 | -9.38 | -5.97 |

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*              HOUSTON PILE GROUP STUDY              *
* FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984  *
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| | NORTH | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 2
CYCLE NO. 1100
LOAD ON GROUP = 64.43 FROM BIG LOAD CELL, KIPS
= 64.83 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .16384 INCHES
WEST CAP DEFL = .54212 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 212. | 170. | 124. | 230. | 215. | 178. | 245. | 147. | 77. | 176. |
| 24. | 306. | 260. | 175. | 327. | 280. | 259. | 322. | 213. | 130. | 253. |
| 36. | 331. | 296. | 210. | 382. | 306. | 295. | 362. | 268. | 173. | 292. |
| 48. | 353. | 320. | 235. | 401. | 367. | 336. | 430. | 289. | 213. | 327. |
| 60. | 342. | 352. | 243. | 395. | 369. | 368. | 394. | 288. | 215. | 330. |
| 72. | 286. | 346. | 235. | 359. | 349. | 355. | 364. | 267. | 237. | 311. |
| 84. | 211. | 296. | 210. | 295. | 285. | 326. | 294. | 220. | 243. | 264. |
| 96. | 114. | 253. | 147. | 212. | 203. | 255. | 176. | 134. | 183. | 186. |
| 114. | 24. | 173. | -21. | 136. | 106. | 184. | 68. | 46. | 142. | 95. |
| 132. | -52. | 100. | 47. | 95. | 61. | 134. | 17. | 6. | 111. | 58. |
| 156. | -44. | 42. | 23. | 41. | 2. | 51. | -10. | -16. | 43. | 15. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .21 | .46 | .22 | .44 | .35 | .46 | .34 | .22 | .38 | .34 |
| SLOPE | -.00404 | -.00546 | -.00294 | -.00619 | -.00446 | -.00524 | -.00495 | -.00347 | -.00345 | -.00447 |
| LOAD | 9.62 | 7.19 | 4.47 | 8.45 | 8.76 | 7.77 | 9.24 | 5.83 | 3.48 | 7.20 |

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*                HOUSTON PILE GROUP STUDY                  *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984       *
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| | | | |
|---|---|---|---|
| | NORTH | | |
| | D | G | A |
| | F | E | H |
| | B | I | C |
| | PILE LEGEND | | |

LOAD NO. 2
CYCLE NO. 2100
LOAD ON GROUP = -60.77 FROM BIG LOAD CELL, KIPS
= -58.48 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.48906 INCHES
WEST CAP DEFL = -.24902 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -102. | -180. | -248. | -104. | -84. | -99. | -99. | -147. | -215. | -142. |
| 24. | -161. | -261. | -359. | -145. | -119. | -153. | -133. | -210. | -316. | -206. |
| 36. | -184. | -302. | -446. | -190. | -144. | -173. | -169. | -266. | -395. | -252. |
| 48. | -215. | -318. | -471. | -205. | -198. | -205. | -193. | -299. | -398. | -276. |
| 60. | -256. | -298. | -466. | -228. | -232. | -217. | -216. | -328. | -381. | -291. |
| 72. | -268. | -270. | -410. | -236. | -251. | -220. | -237. | -341. | -317. | -263. |
| 84. | -278. | -208. | -347. | -226. | -253. | -212. | -247. | -329. | -247. | -261. |
| 96. | -294. | -172. | -310. | -213. | -282. | -203. | -263. | -334. | -184. | -250. |
| 114. | -261. | -117. | -341. | -159. | -260. | -161. | -249. | -283. | -107. | -215. |
| 132. | -226. | -77. | -137. | -80. | -188. | -86. | -189. | -198. | -59. | -138. |
| 156. | -105. | -21. | -37. | -27. | -106. | -34. | -87. | -86. | -26. | -59. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.56 | -.30 | -.56 | -.31 | -.45 | -.31 | -.45 | -.58 | -.41 | -.44 |
| SLOPE | .00602 | .00435 | .00678 | .00425 | .00430 | .00361 | .00451 | .00621 | .00635 | .00515 |
| LOAD | -5.81 | -7.56 | -10.57 | -4.55 | -4.20 | -5.29 | -4.22 | -5.85 | -10.02 | -6.50 |

HOUSTON PILE GROUP STUCY
FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 3
CYCLE NO. 1001
LOAD ON GROUF = 97.75 FROM BIG LOAD CELL, KIPS
= 88.56 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .27815 INCHES
WEST CAP DEFL = .70731 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 284. | 233. | 171. | 325. | 277. | 242. | 337. | 208. | 112. | 243. |
| 24. | 408. | 347. | 242. | 454. | 360. | 351. | 434. | 295. | 189. | 342. |
| 36. | 438. | 395. | 293. | 520. | 393. | 394. | 477. | 367. | 247. | 392. |
| 48. | 465. | 428. | 327. | 536. | 471. | 448. | 564. | 392. | 299. | 437. |
| 60. | 448. | 468. | 346. | 522. | 473. | 480. | 509. | 390. | 294. | 437. |
| 72. | 380. | 463. | 334. | 475. | 454. | 464. | 465. | 366. | 325. | 414. |
| 84. | 274. | 402. | 305. | 391. | 378. | 426. | 384. | 310. | 329. | 356. |
| 96. | 178. | 352. | 237. | 295. | 292. | 345. | 249. | 216. | 259. | 269. |
| 114. | 76. | 255. | 71. | 197. | 180. | 259. | 129. | 114. | 209. | 166. |
| 132. | -15. | 165. | 100. | 138. | 120. | 188. | 67. | 57. | 160. | 109. |
| 156. | -27. | 70. | 39. | 59. | 32. | 76. | 14. | 3. | 63. | 37. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .35 | .61 | .36 | .60 | .50 | .61 | .48 | .36 | .56 | .49 |
| SLOPE | -.00635 | -.00776 | -.00506 | -.00899 | -.00663 | -.00746 | -.00730 | -.00555 | -.00526 | -.00671 |
| LOAD | 12.94 | 9.38 | 6.39 | 12.00 | 11.31 | 10.52 | 12.51 | 8.12 | 5.38 | 5.84 |

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*              HOUSTON PILE GROUP STUDY               *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984  *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 3
CYCLE NO. 2001
LOAD ON GROUP = -80.93 FROM BIG LOAD CELL, KIPS
= -89.17 FROM SUM OF PILE LOAD CELLS

EAST CAP DEFL = -.72105 INCHES
WEST CAP DEFL = -.42617 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -179. | -290. | -411. | -177. | -186. | -179. | -170. | -248. | -323. | -240. |
| 24. | -265. | -423. | -582. | -247. | -245. | -268. | -226. | -352. | -465. | -341. |
| 36. | -302. | -480. | -699. | -313. | -285. | -299. | -281. | -434. | -571. | -407. |
| 48. | -347. | -495. | -722. | -341. | -360. | -340. | -314. | -472. | -562. | -439. |
| 60. | -394. | -458. | -688. | -372. | -386. | -355. | -348. | -497. | -527. | -447. |
| 72. | -405. | -404. | -598. | -379. | -396. | -351. | -374. | -503. | -445. | -428. |
| 84. | -426. | -308. | -506. | -367. | -385. | -330. | -383. | -476. | -350. | -392. |
| 96. | -421. | -257. | -439. | -345. | -405. | -310. | -389. | -467. | -271. | -367. |
| 114. | -369. | -181. | -411. | -273. | -364. | -254. | -357. | -392. | -176. | -309. |
| 132. | -311. | -121. | -208. | -162. | -268. | -155. | -276. | -278. | -118. | -211. |
| 156. | -145. | -40. | -69. | -64. | -152. | -65. | -124. | -123. | -60. | -93. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.79 | -.50 | -.80 | -.53 | -.67 | -.51 | -.68 | -.81 | -.61 | -.65 |
| SLOPE | .00851 | .00675 | .00960 | .00693 | .00682 | .00569 | .00677 | .00912 | .00929 | .00772 |
| LOAD | -8.37 | -12.07 | -15.63 | -6.87 | -7.61 | -8.40 | -6.42 | -9.34 | -14.47 | -9.91 |

HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 3
CYCLE NO. 1005
LOAD ON GROUP = 91.59 FROM BIG LOAD CELL, KIPS
= 82.73 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .29138 INCHES
WEST CAP DEFL = .72074 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 270. | 218. | 157. | 305. | 256. | 221. | 317. | 191. | 102. | 226. |
| 24. | 396. | 331. | 225. | 434. | 337. | 325. | 415. | 274. | 176. | 324. |
| 36. | 433. | 378. | 276. | 510. | 372. | 373. | 472. | 347. | 234. | 377. |
| 48. | 472. | 413. | 312. | 539. | 455. | 431. | 561. | 378. | 287. | 427. |
| 60. | 463. | 456. | 333. | 536. | 464. | 472. | 522. | 384. | 286. | 435. |
| 72. | 400. | 456. | 325. | 495. | 452. | 462. | 483. | 367. | 316. | 417. |
| 84. | 293. | 399. | 299. | 412. | 383. | 430. | 403. | 316. | 326. | 362. |
| 96. | 195. | 353. | 233. | 307. | 296. | 353. | 260. | 220. | 257. | 275. |
| 114. | 73. | 259. | 74. | 196. | 183. | 265. | 126. | 115. | 208. | 166. |
| 132. | -28. | 170. | 97. | 128. | 118. | 191. | 54. | 51. | 160. | 105. |
| 156. | -43. | 74. | 36. | 52. | 27. | 75. | 2. | -5. | 62. | 31. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .34 | .62 | .36 | .60 | .50 | .62 | .48 | .36 | .55 | .49 |
| SLOPE | -.00623 | -.00745 | -.00480 | -.00889 | -.00640 | -.00726 | -.00722 | -.00539 | -.00513 | -.00653 |
| LOAD | 12.34 | 8.82 | 5.92 | 11.32 | 10.54 | 9.72 | 11.82 | 7.45 | 4.80 | 9.19 |

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* HOUSTON PILE GROUP STUDY *

* FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *

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| | NORTH | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 3
CYCLE NO. 2005
LOAD ON GROUP = -67.95 FROM RIG LOAD CELL, KIPS
= -74.31 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.73443 INCHES
WEST CAP DEFL = -.44040 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -146. | -236. | -337. | -148. | -140. | -144. | -141. | -202. | -275. | -197. |
| 24. | -222. | -351. | -489. | -212. | -192. | -222. | -190. | -291. | -403. | -286. |
| 36. | -260. | -413. | -610. | -275. | -232. | -254. | -245. | -369. | -510. | -352. |
| 48. | -304. | -446. | -655. | -305. | -310. | -299. | -275. | -417. | -521. | -392. |
| 60. | -357. | -432. | -650. | -341. | -350. | -323. | -315. | -457. | -509. | -415. |
| 72. | -375. | -400. | -587. | -355. | -372. | -331. | -347. | -477. | -448. | -410. |
| 84. | -406. | -320. | -510. | -351. | -375. | -322. | -363. | -466. | -363. | -386. |
| 96. | -407. | -265. | -452. | -338. | -405. | -310. | -379. | -469. | -286. | -368. |
| 114. | -371. | -191. | -428. | -278. | -372. | -264. | -359. | -404. | -188. | -317. |
| 132. | -323. | -128. | -224. | -174. | -281. | -168. | -288. | -295. | -126. | -223. |
| 156. | -160. | -42. | -78. | -72. | -163. | -74. | -136. | -135. | -64. | -103. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.81 | -.50 | -.81 | -.53 | -.68 | -.51 | -.68 | -.82 | -.61 | -.66 |
| SLOPE | .00782 | .00619 | .00905 | .00641 | .00619 | .00534 | .00630 | .00658 | .00877 | .00718 |
| LOAD | -7.40 | -10.15 | -13.17 | -6.04 | -5.85 | -6.84 | -5.35 | -7.49 | -12.04 | -8.26 |

HOUSTON PILE GROUP STUDY
FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 3
CYCLE NO. 1010
LOAD ON GROUP = 93.69 FROM BIG LOAD CELL, KIPS
= 83.58 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .25848 INCHES
WEST CAP DEFL = .71801 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 273. | 220. | 160. | 308. | 258. | 223. | 321. | 193. | 103. | 229. |
| 24. | 399. | 331. | 228. | 436. | 339. | 326. | 418. | 277. | 176. | 326. |
| 36. | 436. | 378. | 278. | 511. | 374. | 373. | 474. | 349. | 234. | 379. |
| 48. | 474. | 411. | 314. | 540. | 456. | 430. | 564. | 379. | 285. | 428. |
| 60. | 466. | 455. | 334. | 538. | 465. | 473. | 524. | 385. | 286. | 436. |
| 72. | 405. | 456. | 328. | 498. | 454. | 464. | 487. | 369. | 318. | 420. |
| 84. | 297. | 399. | 303. | 415. | 386. | 433. | 407. | 318. | 328. | 365. |
| 96. | 202. | 355. | 236. | 311. | 298. | 355. | 264. | 223. | 261. | 276. |
| 114. | 74. | 261. | 73. | 197. | 185. | 267. | 126. | 116. | 210. | 168. |
| 132. | -30. | 170. | 97. | 127. | 119. | 192. | 52. | 50. | 161. | 104. |
| 156. | -46. | 73. | 36. | 51. | 26. | 76. | 0. | -7. | 63. | 30. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .34 | .62 | .36 | .60 | .50 | .62 | .48 | .35 | .55 | .49 |
| SLOPE | -.00627 | -.00746 | -.00479 | -.00892 | -.00640 | -.00725 | -.00724 | -.00539 | -.00513 | -.00654 |
| LOAD | 12.53 | 8.52 | 6.02 | 11.39 | 10.64 | 9.75 | 11.93 | 7.54 | 4.86 | 9.29 |

**HOUSTON PILE GROUP STUDY**

**FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984**

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 3
CYCLE NO. 2010
LOAD ON GROUP = -68.86 FROM BIG LOAD CELL, KIPS
= -75.18 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.73842 INCHES
WEST CAP DEFL = -.44364 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -144. | -234. | -333. | -147. | -139. | -142. | -139. | -201. | -274. | [illegible] |
| 24. | -219. | -351. | -484. | -211. | -189. | -220. | -188. | -287. | -401. | [illegible] |
| 36. | -256. | -413. | -605. | -273. | -231. | -252. | -243. | -366. | -509. | [illegible] |
| 48. | -300. | -448. | -650. | -303. | -308. | -298. | -273. | -415. | -521. | [illegible] |
| 60. | -354. | -434. | -649. | -339. | -349. | -322. | -314. | -454. | -510. | -414. |
| 72. | -373. | -402. | -585. | -354. | -371. | -330. | -346. | -476. | -449. | -410. |
| 84. | -404. | -324. | -509. | -351. | -374. | -322. | -362. | -466. | -365. | -386. |
| 96. | -403. | -270. | -452. | -338. | -406. | -310. | -378. | -469. | -267. | -368. |
| 114. | -370. | -192. | -428. | -278. | -371. | -263. | -359. | -404. | -188. | -317. |
| 132. | -323. | -130. | -224. | -177. | -282. | -168. | -290. | -297. | -125. | -224. |
| 156. | -163. | -43. | -77. | -74. | -165. | -74. | -138. | -137. | -63. | -104. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.81 | -.50 | -.81 | -.53 | -.68 | -.52 | -.68 | -.83 | -.62 | -.66 |
| SLOPE | .00788 | .00624 | .00910 | .00641 | .00620 | .00535 | .00629 | .00859 | .00678 | .00720 |
| LOAD | -7.43 | -10.27 | -13.24 | -6.11 | -5.96 | -6.97 | -5.43 | -7.59 | -12.19 | -8.35 |

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*                  HOUSTON PILE GROUP STUDY                   *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984         *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 3
CYCLE NO. 1020
LOAD ON GROUP = 89.30 FROM BIG LOAD CELL, KIPS
= 80.85 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .26821 INCHES
WEST CAP DEFL = .71762 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 267. | 213. | 154. | 298. | 252. | 216. | 312. | 187. | 99. | 222. |
| 24. | 393. | 324. | 222. | 427. | 335. | 320. | 413. | 273. | 172. | 320. |
| 36. | 434. | 378. | 274. | 507. | 371. | 368. | 473. | 346. | 231. | 375. |
| 48. | 475. | 407. | 311. | 539. | 456. | 427. | 565. | 379. | 284. | 427. |
| 60. | 469. | 453. | 332. | 539. | 465. | 470. | 526. | 385. | 284. | 436. |
| 72. | 409. | 457. | 326. | 499. | 454. | 462. | 490. | 368. | 315. | 419. |
| 84. | 300. | 395. | 301. | 416. | 386. | 431. | 410. | 318. | 326. | 365. |
| 96. | 204. | 352. | 234. | 311. | 296. | 354. | 264. | 223. | 258. | 277. |
| 114. | 73. | 260. | 71. | 196. | 184. | 266. | 125. | 114. | 208. | 166. |
| 132. | -33. | 170. | 96. | 125. | 117. | 192. | 49. | 48. | 160. | 103. |
| 156. | -50. | 75. | 35. | 49. | 25. | 76. | -3. | -9. | 62. | 29. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .34 | .62 | .36 | .60 | .50 | .62 | .48 | .36 | .55 | .49 |
| SLOPE | -.00614 | -.00726 | -.00462 | -.00880 | -.00630 | -.00714 | -.00712 | -.00520 | -.00503 | -.00640 |
| LOAD | 12.12 | 8.60 | 5.78 | 11.02 | 10.38 | 9.44 | 11.60 | 7.29 | 4.63 | 8.98 |

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*              HOUSTON PILE GROUP STUDY               *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984  *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 3
CYCLE NO. 2020
LOAD ON GROUP = -70.62 FROM BIG LOAD CELL, KIPS
= -76.44 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.73816 INCHES
WEST CAP DEFL = -.44478 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -142. | -234. | -330. | -146. | -137. | -142. | -138. | -199. | -273. | -193. |
| 24. | -216. | -350. | -481. | -210. | -188. | -220. | -187. | -286. | -400. | -282. |
| 36. | -254. | -413. | -602. | -272. | -230. | -251. | -241. | -364. | -509. | -348. |
| 48. | -297. | -445. | -649. | -302. | -307. | -298. | -271. | -413. | -521. | -390. |
| 60. | -351. | -435. | -648. | -337. | -347. | -322. | -311. | -452. | -511. | -413. |
| 72. | -369. | -405. | -585. | -352. | -370. | -330. | -342. | -475. | -452. | -409. |
| 84. | -401. | -327. | -509. | -350. | -373. | -323. | -359. | -465. | -367. | -386. |
| 96. | -401. | -272. | -453. | -338. | -407. | -312. | -379. | -470. | -290. | -365. |
| 114. | -370. | -192. | -427. | -279. | -372. | -265. | -360. | -404. | -190. | -316. |
| 132. | -324. | -128. | -225. | -177. | -283. | -168. | -291. | -298. | -125. | -224. |
| 156. | -165. | -41. | -79. | -74. | -165. | -74. | -140. | -138. | -63. | -104. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.81 | -.50 | -.80 | -.53 | -.68 | -.52 | -.68 | -.82 | -.61 | -.66 |
| SLOPE | .00795 | .00630 | .00914 | .00637 | .00619 | .00534 | .00627 | .00857 | .00877 | .00721 |
| LOAD | -7.50 | -10.41 | -13.36 | -6.24 | -6.21 | -7.13 | -5.54 | -7.72 | -12.33 | -8.49 |

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*              HOUSTON PILE GROUP STUDY             *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 3
CYCLE NO. 1050
LOAD ON GROUP = 91.84 FROM BIG LOAD CELL, KIPS
= 83.32 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .25568 INCHES
WEST CAP DEFL = .71876 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 272. | 217. | 161. | 303. | 260. | 221. | 318. | 193. | 104. | 228. |
| 24. | 401. | 329. | 230. | 434. | 342. | 324. | 419. | 279. | 177. | 326. |
| 36. | 443. | 377. | 282. | 515. | 377. | 372. | 481. | 352. | 233. | 381. |
| 48. | 485. | 409. | 318. | 547. | 463. | 430. | 574. | 385. | 289. | 433. |
| 60. | 480. | 459. | 339. | 549. | 473. | 476. | 537. | 393. | 290. | 444. |
| 72. | 419. | 456. | 334. | 508. | 462. | 469. | 499. | 376. | 321. | 427. |
| 84. | 307. | 399. | 308. | 424. | 394. | 437. | 416. | 323. | 331. | 371. |
| 96. | 210. | 356. | 239. | 316. | 301. | 358. | 269. | 229. | 263. | 282. |
| 114. | 75. | 262. | 72. | 199. | 186. | 269. | 126. | 115. | 211. | 168. |
| 132. | -34. | 171. | 97. | 126. | 117. | 195. | 48. | 47. | 162. | 103. |
| 156. | -53. | 75. | 36. | 50. | 24. | 77. | -5. | -10. | 63. | 28. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .34 | .63 | .37 | .61 | .50 | .63 | .48 | .36 | .55 | .50 |
| SLOPE | -.00633 | -.00740 | -.00465 | -.00895 | -.00642 | -.00724 | -.00726 | -.00540 | -.00524 | -.00654 |
| LOAD | 12.52 | 8.56 | 6.05 | 11.24 | 10.68 | 9.66 | 11.79 | 7.53 | 4.89 | 9.26 |

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*                 HOUSTON PILE GROUP STUDY                 *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984       *
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| | | | |
|---|---|---|---|
| | NORTH | | |
| | D | G | A |
| | F | E | H |
| | B | I | C |
| | PILE LEGEND | | |

LOAD NO. 3
CYCLE NO. 2050
LOAD ON GROUP = -64.15 FROM BIG LOAD CELL, KIPS
= -70.05 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.72728 INCHES
WEST CAP DEFL = -.44201 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -139. | -235. | -326. | -144. | -136. | -141. | -136. | -198. | -272. | -192. |
| 24. | -211. | -350. | -476. | -205. | -186. | -218. | -183. | -282. | -398. | -279. |
| 36. | -248. | -414. | -597. | -267. | -228. | -250. | -236. | -361. | -510. | -346. |
| 48. | -291. | -452. | -647. | -298. | -308. | -300. | -270. | -415. | -527. | -390. |
| 60. | -349. | -441. | -651. | -338. | -352. | -327. | -314. | -458. | -518. | -417. |
| 72. | -370. | -412. | -587. | -356. | -376. | -336. | -347. | -481. | -458. | -414. |
| 84. | -404. | -333. | -509. | -354. | -377. | -328. | -364. | -470. | -369. | -390. |
| 96. | -402. | -273. | -450. | -340. | -409. | -314. | -381. | -467. | -269. | -369. |
| 114. | -368. | -190. | -426. | -277. | -370. | -262. | -359. | -401. | -187. | -316. |
| 132. | -321. | -126. | -220. | -174. | -280. | -164. | -289. | -295. | -122. | -221. |
| 156. | -164. | -40. | -76. | -72. | -163. | -71. | -140. | -137. | -61. | -103. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.81 | -.50 | -.79 | -.52 | -.67 | -.51 | -.67 | -.82 | -.61 | -.66 |
| SLOPE | .00768 | .00622 | .00911 | .00632 | .00617 | .00532 | .00624 | .00855 | .00864 | .00714 |
| LOAD | -6.70 | -9.53 | -12.35 | -5.63 | -5.58 | -6.44 | -4.98 | -7.09 | -11.74 | -7.78 |

HOUSTON PILE GROUP STUDY
FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 3
CYCLE NO. 1100
LOAD ON GROUP = 92.25 FROM BIG LOAD CELL, KIPS
= 86.23 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .20642 INCHES
WEST CAP DEFL = .70930 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 286. | 224. | 168. | 318. | 273. | 230. | 334. | 203. | 109. | 238. |
| 24. | 417. | 338. | 239. | 452. | 357. | 336. | 438. | 292. | 183. | 339. |
| 36. | 459. | 387. | 291. | 532. | 391. | 376. | 498. | 367. | 241. | 393. |
| 48. | 500. | 427. | 328. | 563. | 478. | 441. | 594. | 398. | 294. | 447. |
| 60. | 492. | 470. | 346. | 559. | 482. | 483. | 546. | 401. | 293. | 453. |
| 72. | 425. | 455. | 338. | 512. | 467. | 473. | 502. | 381. | 322. | 431. |
| 84. | 308. | 399. | 310. | 423. | 395. | 437. | 416. | 324. | 332. | 372. |
| 96. | 214. | 354. | 239. | 314. | 269. | 356. | 266. | 230. | 263. | 278. |
| 114. | 72. | 259. | 70. | 196. | 183. | 265. | 122. | 112. | 210. | 165. |
| 132. | -37. | 168. | 95. | 123. | 113. | 192. | 43. | 43. | 161. | 100. |
| 156. | -57. | 74. | 35. | 48. | 22. | 76. | -9. | -12. | 64. | 27. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .33 | .62 | .37 | .60 | .50 | .62 | .48 | .35 | .55 | .49 |
| SLOPE | -.00659 | -.00770 | -.00474 | -.00927 | -.00667 | -.00749 | -.00746 | -.00553 | -.00540 | -.00676 |
| LOAD | 12.87 | 9.15 | 6.22 | 11.68 | 11.06 | 9.99 | 12.29 | 7.88 | 5.09 | 9.58 |

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* HOUSTON PILE GROUP STUDY *

* FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *

******************************************************

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 3
CYCLE NO. 2100
LOAD ON GROUP = -60.66 FROM BIG LOAD CELL, KIPS
= -68.92 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.73162 INCHES
WEST CAP DEFL = -.44109 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -146. | -250. | -343. | -153. | -149. | -153. | -146. | -213. | -287. | -20[illegible]. |
| 24. | -225. | -376. | -506. | -221. | -207. | -239. | -199. | -308. | -423. | -300. |
| 36. | -266. | -445. | -633. | -287. | -253. | -283. | -255. | -391. | -541. | -373. |
| 48. | -311. | -474. | -678. | -318. | -332. | -322. | -288. | -439. | -549. | -41[illegible]. |
| 60. | -362. | -455. | -670. | -353. | -369. | -344. | -327. | -475. | -530. | -43[illegible]. |
| 72. | -379. | -423. | -596. | -366. | -388. | -348. | -356. | -491. | -466. | -423. |
| 84. | -409. | -338. | -512. | -360. | -383. | -335. | -369. | -473. | -370. | -394. |
| 96. | -399. | -273. | -448. | -341. | -429. | -316. | -382. | -463. | -286. | -371. |
| 114. | -365. | -187. | -422. | -275. | -367. | -258. | -356. | -396. | -184. | -31[illegible]. |
| 132. | -318. | -121. | -215. | -172. | -276. | -159. | -286. | -289. | -118. | -217. |
| 156. | -163. | -37. | -74. | -70. | -160. | -68. | -139. | -134. | -59. | -101. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.80 | -.45 | -.78 | -.51 | -.66 | -.50 | -.66 | -.81 | -.61 | -.65 |
| SLOPE | .00757 | .00620 | .00918 | .00632 | .00626 | .00533 | .00628 | .00850 | .00878 | .00716 |
| LOAD | -6.22 | -9.14 | -11.98 | -5.43 | -6.21 | -6.34 | -4.84 | -7.03 | -11.72 | -7.66 |

AD-A194 216 A LATERIAL-LOAD TEST OF A FULL-SCALE PILE GROUP IN SAND 4/4
(U) TEXAS UNIV AT AUSTIN GEOTECHNICAL ENGINEERING
CENTER C S MORRISON ET AL FEB 88 WES/MP/GL-88-1
UNCLASSIFIED DACW39-83-C-0061 F/G 13/13 NL


1.0
2.8
2.5
3.2
2.2
3.6
4.0
2.0
1.1
1.8
1.2
1.4
1.6

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*               HOUSTON PILE GROUP STUDY            *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *
*****************************************************
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 3
CYCLE NO. 1200
LOAD ON GROUP = 96.39 FROM RIG LOAD CELL, KIPS
= 88.53 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .13036 INCHES
WEST CAP DEFL = .70177 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 288. | 223. | 167. | 320. | 274. | 230. | 338. | 207. | 109. | 239. |
| 24. | 426. | 341. | 241. | 459. | 362. | 339. | 447. | 299. | 185. | 344. |
| 36. | 472. | 392. | 296. | 544. | 399. | 385. | 511. | 377. | 245. | 402. |
| 48. | 515. | 453. | 333. | 575. | 487. | 448. | 611. | 409. | 297. | 459. |
| 60. | 504. | 467. | 351. | 570. | 491. | 491. | 557. | 411. | 297. | 460. |
| 72. | 433. | 462. | 342. | 517. | 474. | 480. | 507. | 387. | 324. | 436. |
| 84. | 310. | 401. | 311. | 424. | 398. | 439. | 417. | 327. | 334. | 373. |
| 96. | 216. | 353. | 238. | 311. | 292. | 357. | 264. | 233. | 264. | 281. |
| 114. | 69. | 256. | 66. | 191. | 181. | 263. | 117. | 108. | 208. | 162. |
| 132. | -42. | 166. | 91. | 116. | 108. | 189. | 36. | 38. | 160. | 96. |
| 156. | -63. | 72. | 32. | 45. | 18. | 74. | -14. | -15. | 63. | 24. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .33 | .62 | .36 | .61 | .50 | .63 | .48 | .36 | .55 | .49 |
| SLOPE | -.00660 | -.00766 | -.00478 | -.00925 | -.00663 | -.00740 | -.00751 | -.00556 | -.00531 | -.00674 |
| LOAD | 13.46 | 9.61 | 6.57 | 12.00 | 11.28 | 10.14 | 12.44 | 7.93 | 5.09 | 9.84 |

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* HOUSTON PILE GROUP STUDY *

* FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *

******************************************************

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 3
CYCLE NO. 2200
LOAD ON GROUP = -72.33 FROM BIG LOAD CELL, KIPS
= -78.01 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -.74176 INCHES
WEST CAP DEFL = -.45321 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -137. | -241. | -332. | -144. | -141. | -145. | -135. | -203. | -278. | -195. |
| 24. | -211. | -365. | -490. | -210. | -197. | -229. | -185. | -293. | -411. | -288. |
| 36. | -251. | -433. | -618. | -273. | -242. | -270. | -240. | -376. | -532. | -359. |
| 48. | -295. | -454. | -667. | -304. | -322. | -314. | -268. | -427. | -543. | -399. |
| 60. | -348. | -457. | -662. | -339. | -360. | -336. | -311. | -464. | -526. | -423. |
| 72. | -365. | -418. | -588. | -354. | -378. | -340. | -339. | -482. | -462. | -414. |
| 84. | -398. | -334. | -504. | -350. | -373. | -328. | -353. | -464. | -364. | -385. |
| 96. | -382. | -267. | -438. | -329. | -407. | -306. | -367. | -449. | -278. | -358. |
| 114. | -353. | -178. | -409. | -264. | -354. | -246. | -344. | -383. | -175. | -301. |
| 132. | -308. | -111. | -203. | -164. | -265. | -147. | -278. | -277. | -108. | -207. |
| 156. | -161. | -31. | -67. | -67. | -152. | -60. | -136. | -127. | -52. | -95. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -.80 | -.49 | -.78 | -.51 | -.66 | -.49 | -.66 | -.80 | -.60 | -.64 |
| SLOPE | .00757 | .00612 | .00908 | .00611 | .00601 | .00516 | .00596 | .00844 | .00859 | .00700 |
| LOAD | -7.21 | -10.33 | -13.30 | -6.15 | -8.11 | -7.29 | -5.40 | -7.76 | -12.46 | -8.67 |

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*                HOUSTON PILE GROUP STUDY                 *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984      *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 4
CYCLE NO. 1001
LOAD ON GROUP = 148.21 FROM BIG LOAD CELL, KIPS
= 143.34 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .55866 INCHES
WEST CAP DEFL = 1.23746 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 473. | 370. | 306. | 542. | 442. | 392. | 555. | 365. | 206. | 406. |
| 24. | 685. | 554. | 439. | 765. | 575. | 583. | 724. | 515. | 337. | 575. |
| 36. | 754. | 643. | 542. | 894. | 643. | 657. | 810. | 643. | 442. | 670. |
| 48. | 820. | 741. | 610. | 930. | 781. | 752. | 953. | 692. | 516. | 755. |
| 60. | 803. | 755. | 647. | 914. | 782. | 803. | 873. | 697. | 514. | 755. |
| 72. | 706. | 771. | 643. | 843. | 769. | 792. | 788. | 671. | 568. | 728. |
| 84. | 543. | 686. | 603. | 712. | 672. | 738. | 678. | 594. | 580. | 645. |
| 96. | 429. | 627. | 519. | 568. | 560. | 623. | 482. | 478. | 489. | 531. |
| 114. | 249. | 494. | 317. | 402. | 411. | 496. | 306. | 327. | 425. | 381. |
| 132. | 100. | 366. | 297. | 280. | 302. | 380. | 208. | 217. | 337. | 276. |
| 156. | 13. | 166. | 124. | 127. | 128. | 165. | 78. | 71. | 159. | 115. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .81 | 1.13 | .87 | 1.12 | 1.01 | 1.14 | .97 | .84 | 1.06 | .99 |
| SLOPE | -.01262 | -.01346 | -.01018 | -.01642 | -.01210 | -.01320 | -.01340 | -.01128 | -.01068 | -.01259 |
| LOAD | 20.94 | 14.36 | 10.95 | 19.73 | 17.47 | 16.75 | 20.08 | 13.61 | 9.45 | 15.93 |

HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 4
CYCLE NO. 2001
LOAD ON GROUP = -133.60 FROM BIG LOAD CELL, KIPS
= -148.32 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -1.23378 INCHES
WEST CAP DEFL = -.88124 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -269. | -474. | -606. | -281. | -324. | -303. | -270. | -383. | -485. | -377. |
| 24. | -400. | -714. | -882. | -403. | -438. | -456. | -369. | -550. | -708. | -547. |
| 36. | -471. | -825. | -1082. | -505. | -519. | -536. | -464. | -687. | -891. | -664. |
| 48. | -562. | -862. | -1137. | -572. | -641. | -612. | -513. | -754. | -884. | -726. |
| 60. | -631. | -834. | -1093. | -619. | -682. | -639. | -585. | -795. | -833. | -746. |
| 72. | -654. | -742. | -957. | -647. | -682. | -647. | -641. | -805. | -742. | -724. |
| 84. | -679. | -610. | -827. | -642. | -659. | -612. | -654. | -766. | -592. | -671. |
| 96. | -652. | -488. | -702. | -616. | -684. | -580. | -651. | -733. | -475. | -623. |
| 114. | -588. | -356. | -623. | -522. | -594. | -477. | -593. | -620. | -336. | -523. |
| 132. | -499. | -250. | -361. | -371. | -459. | -326. | -493. | -463. | -250. | -386. |
| 156. | -258. | -96. | -137. | -164. | -266. | -149. | -250. | -215. | -135. | -186. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -1.31 | -.97 | -1.31 | -1.01 | -1.16 | -.98 | -1.18 | -1.32 | -1.10 | -1.15 |
| SLOPE | .01313 | .01212 | .01506 | .01201 | .01152 | .01033 | .01121 | .01423 | .01454 | .01268 |
| LOAD | -12.35 | -19.08 | -22.83 | -10.74 | -15.18 | -14.07 | -10.04 | -14.47 | -21.58 | -15.59 |

HOUSTON PILE GROUP STUDY
FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 4
CYCLE NO. 1005
LOAD ON GROUP = 135.64 FROM BIG LOAD CELL, KIPS
= 130.36 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .56023 INCHES
WEST CAP DEFL = 1.28554 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 436. | 339. | 275. | 500. | 401. | 355. | 515. | 326. | 183. | 370. |
| 24. | 653. | 508. | 398. | 716. | 527. | 530. | 682. | 465. | 302. | 531. |
| 36. | 729. | 600. | 498. | 853. | 595. | 611. | 788. | 587. | 404. | 629. |
| 48. | 813. | 699. | 564. | 915. | 736. | 707. | 937. | 649. | 478. | 722. |
| 60. | 819. | 725. | 611. | 928. | 755. | 779. | 892. | 671. | 489. | 741. |
| 72. | 742. | 745. | 617. | 879. | 762. | 784. | 829. | 664. | 546. | 730. |
| 84. | 586. | 679. | 590. | 760. | 681. | 745. | 730. | 603. | 568. | 660. |
| 96. | 470. | 627. | 515. | 612. | 580. | 643. | 526. | 496. | 487. | 551. |
| 114. | 269. | 511. | 327. | 429. | 434. | 524. | 326. | 347. | 431. | 400. |
| 132. | 99. | 392. | 315. | 286. | 322. | 411. | 207. | 233. | 353. | 291. |
| 156. | -7. | 189. | 138. | 121. | 138. | 182. | 63. | 73. | 178. | 119. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .81 | 1.17 | .86 | 1.14 | 1.02 | 1.17 | .98 | .85 | 1.07 | 1.01 |
| SLOPE | -.01249 | -.01315 | -.00993 | -.01633 | -.01183 | -.01257 | -.01334 | -.01086 | -.01041 | -.01237 |
| LOAD | 19.40 | 13.03 | 9.80 | 18.30 | 15.86 | 15.06 | 18.63 | 12.05 | 8.23 | 14.48 |

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* HOUSTON PILE GROUP STUDY *

* FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *

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NORTH

| | | |
|---|---|---|
| C | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 4
CYCLE NO. 2005
LOAD ON GROUP = -113.04 FROM BIG LOAD CELL, KIPS
= -114.90 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -1.31436 INCHES
WEST CAP DEFL = -.53211 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -219. | -376. | -483. | -232. | -242. | -239. | -219. | -307. | -396. | -302. |
| 24. | -330. | -578. | -717. | -343. | -338. | -367. | -304. | -446. | -586. | -445. |
| 36. | -400. | -688. | -917. | -438. | -418. | -449. | -401. | -578. | -767. | -562. |
| 48. | -492. | -759. | -1020. | -509. | -549. | -533. | -445. | -663. | -798. | -641. |
| 60. | -572. | -781. | -1021. | -574. | -614. | -590. | -531. | -727. | -792. | -688. |
| 72. | -608. | -732. | -940. | -607. | -639. | -610. | -596. | -766. | -745. | -694. |
| 84. | -650. | -629. | -846. | -619. | -643. | -605. | -625. | -753. | -619. | -666. |
| 96. | -634. | -515. | -734. | -609. | -682. | -584. | -639. | -743. | -509. | -628. |
| 114. | -595. | -389. | -675. | -535. | -616. | -500. | -600. | -648. | -369. | -547. |
| 132. | -524. | -279. | -407. | -403. | -492. | -366. | -518. | -505. | -276. | -419. |
| 156. | -294. | -110. | -162. | -189. | -297. | -172. | -279. | -247. | -149. | -211. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -1.35 | -1.00 | -1.34 | -1.03 | -1.20 | -1.01 | -1.21 | -1.36 | -1.13 | -1.18 |
| SLOPE | .01241 | .01124 | .01441 | .01142 | .01075 | .00993 | .01069 | .01383 | .01392 | .01207 |
| LOAD | -10.93 | -15.77 | -18.97 | -9.42 | -11.08 | -11.47 | -8.32 | -11.67 | -17.27 | -12.77 |

HOUSTON PILE GROUP STUDY
FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 4
CYCLE NO. 1010
LOAD ON GROUP = 135.16 FROM BIG LOAD CELL, KIPS
= 129.85 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .57501 INCHES
WEST CAP DEFL = 1.28459 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 435. | 336. | 272. | 495. | 400. | 351. | 510. | 325. | 182. | 367. |
| 24. | 652. | 503. | 393. | 711. | 527. | 526. | 680. | 466. | 300. | 529. |
| 36. | 731. | 597. | 494. | 851. | 596. | 610. | 790. | 590. | 404. | 629. |
| 48. | 820. | 697. | 561. | 918. | 739. | 705. | 942. | 654. | 476. | 723. |
| 60. | 830. | 723. | 610. | 935. | 760. | 780. | 903. | 677. | 490. | 745. |
| 72. | 756. | 749. | 618. | 890. | 768. | 786. | 841. | 673. | 546. | 736. |
| 84. | 600. | 681. | 593. | 773. | 688. | 747. | 745. | 612. | 570. | 668. |
| 96. | 483. | 630. | 519. | 624. | 585. | 648. | 537. | 505. | 491. | 558. |
| 114. | 275. | 517. | 320. | 435. | 440. | 529. | 333. | 353. | 435. | 404. |
| 132. | 100. | 400. | 321. | 288. | 326. | 416. | 209. | 236. | 357. | 295. |
| 156. | -12. | 195. | 138. | 120. | 137. | 185. | 58. | 71. | 180. | 119. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .81 | 1.17 | .87 | 1.15 | 1.02 | 1.17 | .98 | .85 | 1.07 | 1.01 |
| SLOPE | -.01257 | -.01315 | -.00994 | -.01640 | -.01188 | -.01259 | -.01341 | -.01091 | -.01043 | -.01241 |
| LOAD | 19.34 | 12.96 | 9.75 | 18.14 | 15.88 | 14.97 | 18.53 | 12.06 | 8.22 | 14.43 |

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*****************************************************
*               HOUSTON PILE GROUP STUDY            *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *
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| | | |
|---|---|---|
| NORTH | | |
| D | C | A |
| F | E | H |
| F | I | C |

PILE LEGEND

LOAD NO. 4
CYCLE NO. 2810
LOAD ON GROUP = -112.73 FROM BIG LOAD CELL, KIPS
= -113.91 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -1.33057 INCHES
WEST CAP DEFL = -.94086 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -213. | -368. | -474. | -228. | -238. | -235. | -216. | -300. | -390. | -296. |
| 24. | -320. | -566. | -705. | -337. | -331. | -361. | -298. | -436. | -576. | -437. |
| 36. | -390. | -676. | -903. | -429. | -411. | -441. | -393. | -566. | -758. | -552. |
| 48. | -478. | -751. | -1016. | -500. | -541. | -526. | -436. | -651. | -795. | -633. |
| 60. | -560. | -780. | -1019. | -566. | -607. | -576. | -522. | -718. | -793. | -682. |
| 72. | -597. | -737. | -943. | -600. | -635. | -606. | -589. | -759. | -752. | -691. |
| 84. | -643. | -636. | -854. | -614. | -643. | -607. | -619. | -751. | -629. | -666. |
| 96. | -629. | -526. | -742. | -608. | -684. | -586. | -636. | -744. | -518. | -630. |
| 114. | -596. | -394. | -701. | -537. | -619. | -503. | -601. | -652. | -375. | -553. |
| 132. | -530. | -281. | -410. | -408. | -496. | -372. | -522. | -511. | -278. | -423. |
| 156. | -302. | -108. | -166. | -194. | -302. | -174. | -285. | -253. | -149. | -215. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -1.36 | -1.01 | -1.34 | -1.03 | -1.20 | -1.01 | -1.21 | -1.36 | -1.13 | -1.18 |
| SLOPE | .01238 | .01123 | .01438 | .01138 | .01074 | .00992 | .01065 | .01383 | .01393 | .01225 |
| LOAD | -10.85 | -15.69 | -18.86 | -9.42 | -10.40 | -11.48 | -8.35 | -11.62 | -17.24 | -12.46 |

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*               HOUSTON PILE GROUP STUDY                    *
*   FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984      *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 4
CYCLE NO. 1020
LOAD ON GROUP = 136.14 FROM BIG LOAD CELL, KIPS
= 130.82 FROM SUM OF PILE LOAD CELLS

EAST CAP DEFL = .59326 INCHES
WEST CAP DEFL = 1.22354 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 434. | 333. | 262. | 497. | 398. | 347. | 506. | 324. | 181. | 365. |
| 24. | 644. | 499. | 382. | 705. | 523. | 518. | 668. | 462. | 300. | 522. |
| 36. | 718. | 595. | 483. | 841. | 591. | 603. | 777. | 584. | 404. | 622. |
| 48. | 806. | 695. | 549. | 908. | 733. | 698. | 926. | 647. | 472. | 715. |
| 60. | 816. | 721. | 601. | 926. | 755. | 745. | 890. | 672. | 492. | 735. |
| 72. | 746. | 750. | 611. | 884. | 766. | 785. | 834. | 669. | 549. | 733. |
| 84. | 594. | 683. | 592. | 771. | 688. | 747. | 742. | 611. | 574. | 667. |
| 96. | 483. | 636. | 521. | 627. | 585. | 652. | 541. | 510. | 498. | 562. |
| 114. | 281. | 525. | 352. | 443. | 447. | 536. | 341. | 362. | 443. | 414. |
| 132. | 110. | 408. | 329. | 296. | 331. | 423. | 218. | 245. | 362. | 302. |
| 156. | -4. | 201. | 143. | 126. | 142. | 190. | 66. | 77. | 184. | 125. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .83 | 1.18 | .88 | 1.16 | 1.04 | 1.18 | .99 | .87 | 1.09 | 1.02 |
| SLOPE | -.01270 | -.01345 | -.01010 | -.01663 | -.01205 | -.01311 | -.01354 | -.01106 | -.01053 | -.01257 |
| LOAD | 19.26 | 13.57 | 10.10 | 17.93 | 16.04 | 15.09 | 18.03 | 12.18 | 8.62 | 14.54 |

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*                 HOUSTON PILE GROUP STUDY                 *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984      *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| H | I | C |

PILE LEGEND

LOAD NO. 4
CYCLE NO. 2020
LOAD ON GROUP = -108.94 FROM BIG LOAD CELL, KIPS
= -110.08 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -1.11434 INCHES
WEST CAP DEFL = -.84952 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -204. | -379. | -456. | -239. | -240. | -246. | -216. | -291. | -386. | -295. |
| 24. | -303. | -586. | -676. | -353. | -330. | -375. | -296. | -418. | -567. | -434. |
| 36. | -364. | -688. | -852. | -440. | -402. | -449. | -380. | -532. | -737. | -538. |
| 48. | -435. | -756. | -943. | -504. | -519. | -527. | -419. | -602. | -768. | -608. |
| 60. | -506. | -777. | -934. | -562. | -573. | -581. | -493. | -653. | -758. | -649. |
| 72. | -531. | -726. | -854. | -588. | -592. | -591. | -547. | -684. | -711. | -647. |
| 84. | -573. | -620. | -761. | -596. | -593. | -590. | -569. | -669. | -585. | -617. |
| 96. | -552. | -503. | -650. | -580. | -636. | -557. | -581. | -654. | -471. | -576. |
| 114. | -519. | -363. | -581. | -502. | -556. | -468. | -542. | -563. | -330. | -492. |
| 132. | -456. | -247. | -334. | -370. | -440. | -337. | -462. | -430. | -232. | -368. |
| 156. | -259. | -85. | -129. | -169. | -264. | -153. | -247. | -210. | -120. | -182. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -1.17 | -.54 | -1.16 | -.97 | -1.09 | -.95 | -1.09 | -1.19 | -1.02 | -1.06 |
| SLOPE | .01110 | .01113 | .01302 | .01101 | .00988 | .00963 | .00979 | .01242 | .01292 | .01121 |
| LOAD | -9.87 | -15.67 | -17.75 | -9.42 | -10.07 | -11.58 | -7.96 | -10.96 | -16.80 | -12.23 |

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*                HOUSTON PILE GROUP STUDY                *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 4
CYCLE NO. 1050
LOAD ON GROUP = 131.81 FROM BIG LOAD CELL, KIPS
= 128.38 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .55956 INCHES
WEST CAP DEFL = 1.20447 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 442. | 325. | 253. | 495. | 396. | 339. | 504. | 319. | 178. | 361. |
| 24. | 645. | 493. | 373. | 709. | 523. | 509. | 671. | 460. | 294. | 520. |
| 36. | 726. | 587. | 473. | 854. | 594. | 597. | 790. | 584. | 398. | 623. |
| 48. | 818. | 687. | 540. | 926. | 737. | 694. | 942. | 649. | 462. | 717. |
| 60. | 830. | 712. | 593. | 946. | 760. | 743. | 909. | 677. | 495. | 741. |
| 72. | 760. | 742. | 606. | 901. | 773. | 789. | 851. | 675. | 546. | 738. |
| 84. | 604. | 677. | 595. | 782. | 695. | 749. | 754. | 617. | 573. | 672. |
| 96. | 493. | 631. | 523. | 630. | 587. | 652. | 548. | 516. | 501. | 565. |
| 114. | 283. | 522. | 349. | 435. | 447. | 533. | 338. | 366. | 444. | 413. |
| 132. | 109. | 406. | 337. | 281. | 327. | 419. | 210. | 248. | 364. | 300. |
| 156. | -7. | 202. | 152. | 114. | 141. | 188. | 58. | 79. | 188. | 124. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .83 | 1.16 | .89 | 1.15 | 1.03 | 1.18 | .99 | .87 | 1.09 | 1.02 |
| SLOPE | -.01275 | -.01336 | -.01007 | -.01670 | -.01208 | -.01305 | -.01360 | -.01116 | -.01053 | -.01259 |
| LOAD | 19.01 | 13.23 | 9.73 | 17.75 | 15.82 | 14.66 | 17.87 | 11.96 | 8.35 | 14.26 |

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*                HOUSTON PILE GROUP STUDY               *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984    *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 4
CYCLE NO. 2050
LOAD ON GROUP = -102.74 FROM BIG LOAD CELL, KIPS
= -109.07 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -1.12859 INCHES
WEST CAP DEFL = -.86044 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -203. | -384. | -466. | -234. | -242. | -246. | -214. | -292. | -393. | -297. |
| 24. | -301. | -594. | -692. | -358. | -333. | -376. | -294. | -420. | -580. | -439. |
| 36. | -362. | -702. | -877. | -434. | -409. | -456. | -378. | -539. | -760. | -546. |
| 48. | -436. | -778. | -972. | -500. | -531. | -537. | -418. | -612. | -796. | -620. |
| 60. | -506. | -800. | -960. | -559. | -585. | -593. | -494. | -662. | -779. | -660. |
| 72. | -529. | -747. | -872. | -588. | -602. | -602. | -546. | -691. | -729. | -656. |
| 84. | -572. | -631. | -769. | -597. | -599. | -603. | -568. | -672. | -595. | -624. |
| 96. | -545. | -509. | -648. | -580. | -635. | -565. | -578. | -649. | -472. | -576. |
| 114. | -510. | -362. | -579. | -503. | -550. | -466. | -536. | -550. | -322. | -486. |
| 132. | -445. | -239. | -311. | -373. | -432. | -332. | -456. | -414. | -219. | -358. |
| 156. | -251. | -78. | -109. | -172. | -255. | -148. | -243. | -198. | -107. | -173. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -1.16 | -.94 | -1.15 | -.97 | -1.08 | -.95 | -1.09 | -1.17 | -1.01 | -1.06 |
| SLOPE | .01087 | .01117 | .01292 | .01081 | .00980 | .00959 | .00962 | .01222 | .01293 | .01110 |
| LOAD | -9.22 | -15.10 | -17.46 | -8.86 | -11.60 | -11.28 | -7.70 | -10.85 | -16.99 | -12.12 |

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*              HOUSTON PILE GROUP STUDY             *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 4
CYCLE NO. 1100
LOAD ON GROUP = 138.84 FROM BIG LOAD CELL, KIPS
= 133.74 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .58255 INCHES
WEST CAP DEFL = 1.19209 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 455. | 32[illegible]. | 251. | 509. | 403. | 340. | 520. | 323. | 180. | 367. |
| 24. | 666. | 499. | 373. | 734. | 536. | 512. | 697. | 468. | 299. | 532. |
| 36. | 752. | 606. | 476. | 885. | 610. | 604. | 821. | 597. | 407. | 64[illegible]. |
| 48. | 845. | 696. | 544. | 957. | 755. | 704. | 981. | 664. | 465. | 735. |
| 60. | 853. | 720. | 599. | 972. | 776. | 754. | 938. | 690. | 505. | 756. |
| 72. | 775. | 748. | 609. | 917. | 784. | 798. | 866. | 684. | 547. | 748. |
| 84. | 611. | 685. | 595. | 789. | 699. | 752. | 760. | 623. | 576. | 677. |
| 56. | 492. | 630. | 520. | 627. | 589. | 649. | 544. | 516. | 499. | 563. |
| 114. | 275. | 520. | 347. | 425. | 441. | 528. | 328. | 361. | 439. | 407. |
| 132. | 98. | 404. | 333. | 267. | 319. | 410. | 195. | 241. | 360. | 292. |
| 156. | -16. | 202. | 151. | 105. | 133. | 183. | 46. | 75. | 185. | 118. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .83 | 1.16 | .69 | 1.15 | 1.03 | 1.17 | .99 | .87 | 1.09 | 1.02 |
| SLOPE | -.01301 | -.01339 | -.01003 | -.01688 | -.01219 | -.01310 | -.01379 | -.01124 | -.01056 | -.01269 |
| LOAD | 20.19 | 13.74 | 10.16 | 18.70 | 16.50 | 15.04 | 18.68 | 12.19 | 8.55 | 14.86 |

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*               HOUSTON PILE GROUP STUDY              *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984  *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 4
CYCLE NO. 2100
LOAD ON GROUP = -112.22 FROM PIG LOAD CELL, KIPS
= -113.00 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -1.10528 INCHES
WEST CAP DEFL = -.86829 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -199. | -397. | -482. | -227. | -248. | -246. | -212. | -292. | -406. | -301. |
| 24. | -294. | -614. | -718. | -356. | -343. | -379. | -292. | -422. | -601. | -446. |
| 36. | -358. | -718. | -907. | -426. | -421. | -461. | -374. | -543. | -787. | -555. |
| 48. | -428. | -804. | -1001. | -494. | -544. | -545. | -414. | -617. | -824. | -630. |
| 60. | -499. | -819. | -979. | -553. | -594. | -601. | -489. | -667. | -798. | -667. |
| 72. | -522. | -757. | -882. | -583. | -610. | -610. | -541. | -694. | -740. | -660. |
| 84. | -567. | -638. | -772. | -594. | -603. | -613. | -564. | -672. | -595. | -624. |
| 96. | -541. | -503. | -644. | -577. | -634. | -571. | -575. | -645. | -468. | -573. |
| 114. | -506. | -353. | -549. | -503. | -545. | -461. | -533. | -543. | -313. | -478. |
| 132. | -441. | -226. | -296. | -372. | -424. | -324. | -454. | -404. | -208. | -350. |
| 156. | -251. | -67. | -99. | -173. | -248. | -143. | -244. | -192. | -99. | -168. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -1.15 | -.93 | -1.14 | -.97 | -1.07 | -.95 | -1.08 | -1.16 | -1.00 | -1.05 |
| SLOPE | .01063 | .01118 | .01292 | .01061 | .00974 | .00951 | .00948 | .01210 | .01297 | .01131 |
| LOAD | -9.67 | -16.29 | -18.76 | -9.14 | -10.62 | -11.64 | -7.84 | -11.11 | -17.83 | -12.56 |

HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

| | | | |
|---|---|---|---|
| NORTH | | | |
| D | G | A | |
| F | E | H | |
| B | I | C | |
| PILE LEGEND | | | |

LOAD NO. 4
CYCLE NO. 1200
LOAD ON GROUP = 137.04 FROM BIG LOAD CELL, KIPS
= 131.61 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = .59203 INCHES
WEST CAP DEFL = 1.18446 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 451. | 310. | 241. | 509. | 404. | 339. | 528. | 320. | 181. | 365. |
| 24. | 690. | 499. | 376. | 755. | 547. | 515. | 712. | 463. | 293. | 539. |
| 36. | 771. | 594. | 465. | 899. | 611. | 593. | 834. | 580. | 399. | 638. |
| 48. | 863. | 683. | 537. | 982. | 767. | 708. | 1022. | 673. | 465. | 745. |
| 60. | 882. | 724. | 608. | 1008. | 796. | 765. | 972. | 701. | 505. | 774. |
| 72. | 794. | 744. | 607. | 938. | 793. | 804. | 888. | 693. | 544. | 756. |
| 84. | 623. | 702. | 599. | 790. | 712. | 761. | 775. | 635. | 585. | 687. |
| 96. | 500. | 630. | 524. | 629. | 592. | 647. | 546. | 521. | 500. | 565. |
| 114. | 272. | 519. | 319. | 416. | 437. | 523. | 319. | 362. | 439. | 401. |
| 132. | 90. | 402. | 336. | 249. | 312. | 404. | 181. | 239. | 359. | 286. |
| 156. | -25. | 203. | 155. | 91. | 127. | 177. | 33. | 72. | 186. | 113. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | .83 | 1.16 | .89 | 1.15 | 1.03 | 1.17 | .99 | .88 | 1.08 | 1.02 |
| SLOPE | -.01312 | -.01325 | -.01005 | -.01703 | -.01226 | -.01310 | -.01390 | -.01121 | -.01059 | -.01272 |
| LOAD | 20.17 | 13.33 | 9.83 | 18.70 | 16.33 | 14.79 | 18.59 | 11.77 | 8.10 | 14.62 |

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* HOUSTON PILE GROUP STUDY *

* FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *

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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 4
CYCLE NO. 2200
LOAD ON GROUP = -107.08 FROM BIG LOAD CELL, KIPS
= -107.68 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -1.12466 INCHES
WEST CAP DEFL = -.87496 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -188. | -394. | -480. | -218. | -241. | -239. | -205. | -284. | -405. | -295. |
| 24. | -284. | -615. | -723. | -348. | -339. | -373. | -286. | -414. | -603. | -443. |
| 36. | -350. | -725. | -925. | -419. | -425. | -460. | -370. | -541. | -799. | -558. |
| 48. | -424. | -825. | -1028. | -489. | -555. | -551. | -395. | -624. | -847. | -637. |
| 60. | -498. | -844. | -1007. | -549. | -607. | -614. | -490. | -680. | -824. | -679. |
| 72. | -522. | -777. | -903. | -584. | -622. | -623. | -541. | -708. | -761. | -671. |
| 84. | -570. | -629. | -784. | -615. | -612. | -625. | -565. | -684. | -665. | -632. |
| 96. | -538. | -506. | -648. | -577. | -641. | -584. | -575. | -650. | -471. | -577. |
| 114. | -504. | -348. | -575. | -502. | -543. | -459. | -532. | -541. | -310. | -479. |
| 132. | -439. | -212. | -281. | -370. | -418. | -315. | -451. | -397. | -197. | -342. |
| 156. | -250. | -57. | -86. | -173. | -240. | -135. | -243. | -185. | -87. | -162. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -1.15 | -.93 | -1.13 | -.96 | -1.06 | -.94 | -1.07 | -1.15 | -.99 | -1.04 |
| SLOPE | .01023 | .01104 | .01285 | .01037 | .00963 | .00935 | .00927 | .01202 | .01287 | .01085 |
| LOAD | -8.98 | -15.90 | -18.21 | -8.49 | -10.17 | -10.93 | -7.24 | -10.41 | -17.35 | -11.96 |

HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

| | NORTH | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 5
CYCLE NO. 1001
LOAD ON GROUP = 181.12 FROM BIG LOAD CELL, KIPS
= 179.42 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = 1.10607 INCHES
WEST CAP DEFL = 1.71696 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 635. | 437. | 361. | 702. | 561. | 477. | 736. | 459. | 263. | 515. |
| 24. | 935. | 669. | 536. | 1020. | 748. | 723. | 986. | 662. | 429. | 745. |
| 36. | 1059. | 815. | 687. | 1231. | 859. | 850. | 1149. | 847. | 589. | 898. |
| 48. | 1188. | 945. | 795. | 1329. | 1059. | 995. | 1383. | 952. | 664. | 1035. |
| 60. | 1191. | 987. | 888. | 1343. | 1082. | 1064. | 1311. | 992. | 718. | 1064. |
| 72. | 1086. | 1041. | 899. | 1271. | 1098. | 1115. | 1197. | 988. | 785. | 1054. |
| 84. | 876. | 982. | 892. | 1091. | 991. | 1063. | 1056. | 911. | 826. | 965. |
| 96. | 726. | 901. | 802. | 900. | 872. | 927. | 777. | 783. | 729. | 824. |
| 114. | 471. | 774. | 580. | 649. | 682. | 775. | 518. | 600. | 661. | 634. |
| 132. | 255. | 624. | 579. | 441. | 528. | 619. | 367. | 446. | 558. | 491. |
| 156. | 72. | 336. | 288. | 198. | 267. | 297. | 144. | 188. | 318. | 234. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | 1.36 | 1.71 | 1.45 | 1.70 | 1.58 | 1.72 | 1.53 | 1.42 | 1.65 | 1.57 |
| SLOPE | -.01967 | -.01931 | -.01554 | -.02458 | -.01797 | -.01921 | -.02033 | -.01719 | -.01613 | -.01888 |
| LOAD | 26.76 | 17.29 | 13.64 | 25.13 | 21.84 | 20.51 | 25.57 | 16.86 | 11.82 | 19.94 |

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*************************************************************
*                 HOUSTON PILE GROUP STUDY                   *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984         *
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| | | | |
|---|---|---|---|
| | | NORTH | |
| LOAD NO. 5 | D | G | A |
| CYCLE NO. 2001 | | | |
| LOAD ON GROUP = -176.78 FROM BIG LOAD CELL, KIPS | F | E | H |
| = -178.99 FROM SUM OF PILE LOAD CELLS | | | |
| EAST CAP DEFL = -1.71004 INCHES | B | I | C |
| WEST CAP DEFL = -1.37132 INCHES | | | |
| | | PILE LEGEND | |

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -333. | -647. | -787. | -356. | -456. | -418. | -348. | -477. | -639. | -496. |
| 24. | -489. | -1015. | -1180. | -540. | -624. | -629. | -481. | -697. | -954. | -734. |
| 36. | -594. | -1190. | -1491. | -651. | -760. | -766. | -611. | -895. | -1247. | -912. |
| 48. | -711. | -1324. | -1684. | -758. | -942. | -904. | -666. | -1011. | -1279. | -1031. |
| 60. | -807. | -1295. | -1593. | -848. | -994. | -977. | -790. | -1077. | -1207. | -1066. |
| 72. | -848. | -1155. | -1402. | -891. | -989. | -992. | -866. | -1100. | -1103. | -1039. |
| 84. | -898. | -937. | -1191. | -928. | -955. | -971. | -899. | -1050. | -881. | -968. |
| 96. | -857. | -757. | -984. | -887. | -975. | -897. | -893. | -992. | -705. | -883. |
| 114. | -785. | -556. | -826. | -790. | -825. | -717. | -618. | -829. | -491. | -737. |
| 132. | -676. | -368. | -466. | -621. | -641. | -536. | -707. | -626. | -356. | -555. |
| 156. | -382. | -129. | -166. | -304. | -372. | -236. | -391. | -296. | -181. | -273. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -1.78 | -1.47 | -1.77 | -1.52 | -1.65 | -1.51 | -1.68 | -1.79 | -1.59 | -1.64 |
| SLOPE | .01695 | .01792 | .02013 | .01687 | .01612 | .01544 | .01523 | .01859 | .01998 | .01747 |
| LOAD | -14.79 | -25.78 | -29.64 | -13.19 | -17.93 | -18.87 | -12.40 | -18.08 | -28.31 | -15.39 |

HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 5
CYCLE NO. 1005
LOAD ON GROUP = 185.81 FROM BIG LOAD CELL, KIPS
= 181.19 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = 1.09774 INCHES
WEST CAP DEFL = 1.74235 INCHES

| DEPTH, INCHES | BENDING MOMENTS, INCH-KIPS PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 637. | 428. | 361. | 700. | 553. | 474. | 731. | 452. | 258. | 511. |
| 24. | 952. | 654. | 540. | 1025. | 747. | 705. | 992. | 653. | 419. | 743. |
| 36. | 1090. | 797. | 685. | 1244. | 852. | 830. | 1167. | 838. | 580. | 898. |
| 48. | 1234. | 915. | 761. | 1356. | 1056. | 978. | 1412. | 951. | 652. | 1035. |
| 60. | 1244. | 972. | 856. | 1382. | 1086. | 1059. | 1359. | 1001. | 710. | 1074. |
| 72. | 1149. | 1030. | 887. | 1317. | 1110. | 1123. | 1253. | 1007. | 783. | 1073. |
| 84. | 935. | 975. | 898. | 1135. | 1012. | 1075. | 1113. | 937. | 827. | 990. |
| 96. | 775. | 901. | 813. | 934. | 892. | 945. | 819. | 808. | 736. | 847. |
| 114. | 488. | 778. | 585. | 657. | 695. | 786. | 533. | 614. | 674. | 646. |
| 132. | 245. | 629. | 580. | 425. | 530. | 625. | 354. | 447. | 564. | 489. |
| 156. | 41. | 340. | 288. | 173. | 263. | 296. | 117. | 179. | 320. | 224. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | 1.36 | 1.72 | 1.45 | 1.71 | 1.59 | 1.73 | 1.54 | 1.43 | 1.65 | 1.58 |
| SLOPE | -.02010 | -.01913 | -.01573 | -.02484 | -.01803 | -.01908 | -.02062 | -.01724 | -.01623 | -.01900 |
| LOAD | 27.73 | 17.33 | 13.68 | 25.57 | 21.90 | 20.17 | 25.78 | 16.75 | 12.07 | 20.13 |

HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

| | | | |
|---|---|---|---|
| | | NORTH | |
| | D | G | A |
| | F | E | H |
| | B | I | C |
| PILE LEGEND | | | |

LOAD NO. 5
CYCLE NO. 2005
LOAD ON GROUP = -152.10 FROM BIG LOAD CELL, KIPS
= -151.93 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -1.79013 INCHES
WEST CAP DEFL = -1.43136 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -288. | -536. | -654. | -315. | -373. | -354. | -303. | -406. | -544. | -419. |
| 24. | -430. | -849. | -989. | -486. | -520. | -534. | -419. | -593. | -812. | -626. |
| 36. | -539. | -1011. | -1280. | -593. | -647. | -668. | -553. | -779. | -1076. | -794. |
| 48. | -643. | -1168. | -1496. | -701. | -830. | -807. | -604. | -904. | -1146. | -922. |
| 60. | -753. | -1192. | -1485. | -797. | -908. | -898. | -740. | -991. | -1129. | -968. |
| 72. | -805. | -1113. | -1366. | -852. | -931. | -934. | -821. | -1044. | -1078. | -994. |
| 84. | -872. | -939. | -1190. | -850. | -925. | -947. | -870. | -1025. | -895. | -946. |
| 96. | -838. | -786. | -1015. | -875. | -974. | -894. | -878. | -996. | -738. | -888. |
| 114. | -788. | -608. | -890. | -802. | -849. | -746. | -823. | -862. | -537. | -767. |
| 132. | -700. | -420. | -539. | -656. | -688. | -591. | -732. | -681. | -404. | -601. |
| 156. | -423. | -166. | -210. | -339. | -417. | -272. | -428. | -342. | -215. | -312. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -1.84 | -1.52 | -1.81 | -1.57 | -1.71 | -1.55 | -1.72 | -1.83 | -1.63 | -1.69 |
| SLOPE | .01640 | .01655 | .01939 | .01645 | .01531 | .01502 | .01476 | .01843 | .01913 | .01687 |
| LOAD | -13.33 | -21.57 | -24.93 | -11.86 | -14.80 | -15.95 | -10.80 | -15.28 | -23.42 | -16.08 |

HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 5
CYCLE NO. 1010
LOAD ON GROUP = 182.78 FROM BIG LOAD CELL, KIPS
= 177.94 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = 1.11660 INCHES
WEST CAP DEFL = 1.75163 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 622. | 418. | 351. | 681. | 543. | 460. | 714. | 441. | 253. | 498. |
| 24. | 931. | 640. | 529. | 1000. | 723. | 689. | 974. | 638. | 410. | 727. |
| 36. | 1073. | 783. | 669. | 1220. | 838. | 813. | 1152. | 820. | 572. | 882. |
| 48. | 1222. | 904. | 746. | 1338. | 1043. | 960. | 1355. | 936. | 641. | 1021. |
| 60. | 1241. | 961. | 841. | 1371. | 1077. | 1044. | 1355. | 991. | 701. | 1065. |
| 72. | 1154. | 1018. | 876. | 1318. | 1106. | 1114. | 1259. | 1003. | 776. | 1069. |
| 84. | 947. | 975. | 894. | 1158. | 1014. | 1072. | 1127. | 939. | 824. | 995. |
| 96. | 791. | 895. | 816. | 950. | 896. | 947. | 836. | 818. | 737. | 855. |
| 114. | 503. | 784. | 608. | 675. | 706. | 794. | 549. | 626. | 679. | 658. |
| 132. | 259. | 641. | 593. | 441. | 542. | 639. | 367. | 461. | 573. | 502. |
| 156. | 46. | 352. | 298. | 178. | 273. | 308. | 121. | 187. | 331. | 233. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | 1.37 | 1.74 | 1.47 | 1.72 | 1.60 | 1.75 | 1.55 | 1.45 | 1.66 | 1.59 |
| SLOPE | -.02014 | -.01914 | -.01573 | -.02480 | -.01803 | -.01905 | -.02063 | -.01722 | -.01625 | -.01900 |
| LOAD | 27.22 | 17.13 | 13.71 | 25.10 | 21.63 | 19.75 | 25.26 | 16.35 | 11.79 | 19.77 |

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* HOUSTON PILE GROUP STUDY *

* FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *

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LOAD NO. 5
CYCLE NO. 2010
LOAD ON GROUP = -153.13 FROM BIG LOAD CELL, KIPS
= -152.92 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -1.78019 INCHES
WEST CAP DEFL = -1.43475 INCHES

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -280. | -523. | -637. | -308. | -363. | -348. | -256. | -393. | -533. | -409. |
| 24. | -417. | -826. | -963. | -474. | -508. | -523. | -410. | -577. | -797. | -611. |
| 36. | -526. | -990. | -1254. | -582. | -637. | -656. | -543. | -761. | -1060. | -775. |
| 48. | -627. | -1151. | -1476. | -689. | -818. | -794. | -593. | -887. | -1135. | -908. |
| 60. | -738. | -1181. | -1475. | -783. | -897. | -886. | -729. | -976. | -1124. | -976. |
| 72. | -790. | -1111. | -1365. | -840. | -922. | -924. | -809. | -1032. | -1078. | -986. |
| 84. | -861. | -940. | -1193. | -835. | -920. | -941. | -859. | -1018. | -900. | -941. |
| 96. | -830. | -793. | -1021. | -868. | -980. | -892. | -872. | -991. | -745. | -888. |
| 114. | -789. | -615. | -895. | -802. | -851. | -749. | -821. | -866. | -544. | -770. |
| 132. | -706. | -427. | -549. | -661. | -694. | -599. | -735. | -690. | -410. | -608. |
| 156. | -434. | -170. | -218. | -349. | -425. | -279. | -438. | -354. | -219. | -321. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -1.85 | -1.53 | -1.82 | -1.57 | -1.71 | -1.56 | -1.72 | -1.83 | -1.64 | -1.69 |
| SLOPE | .01639 | .01651 | .01935 | .01639 | .01527 | .01458 | .01472 | .01839 | .01908 | .01683 |
| LOAD | -13.42 | -21.60 | -24.91 | -12.04 | -15.37 | -16.06 | -10.96 | -15.20 | -23.36 | -16.99 |

HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

| | | | |
|---|---|---|---|
| | NORTH | | |
| | D | G | A |
| | F | E | H |
| | B | I | C |
| | PILE LEGEND | | |

LOAD NO. 5
CYCLE NO. 1020
LOAD ON GROUP = 175.45 FROM BIG LOAD CELL, KIPS
= 170.42 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = 1.15722 INCHES
WEST CAP DEFL = 1.75779 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 596. | 403. | 338. | 648. | 525. | 441. | 679. | 424. | 246. | 478. |
| 24. | 898. | 621. | 512. | 957. | 714. | 663. | 932. | 615. | 398. | 701. |
| 36. | 1049. | 763. | 650. | 1183. | 820. | 791. | 1127. | 797. | 564. | 861. |
| 48. | 1212. | 887. | 727. | 1318. | 1031. | 940. | 1370. | 920. | 632. | 1004. |
| 60. | 1243. | 948. | 827. | 1367. | 1072. | 1030. | 1355. | 983. | 694. | 1056. |
| 72. | 1165. | 1007. | 864. | 1324. | 1105. | 1106. | 1272. | 1001. | 768. | 1068. |
| 84. | 963. | 969. | 886. | 1171. | 1016. | 1067. | 1146. | 942. | 819. | 598. |
| 96. | 805. | 893. | 812. | 965. | 901. | 945. | 853. | 826. | 734. | 659. |
| 114. | 513. | 785. | 591. | 687. | 710. | 796. | 561. | 632. | 679. | 662. |
| 132. | 265. | 648. | 599. | 452. | 546. | 645. | 375. | 469. | 576. | 506. |
| 156. | 46. | 363. | 306. | 182. | 278. | 316. | 120. | 193. | 337. | 238. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | 1.39 | 1.75 | 1.48 | 1.74 | 1.61 | 1.76 | 1.56 | 1.46 | 1.67 | 1.60 |
| SLOPE | -.02006 | -.01858 | -.01562 | -.02463 | -.01795 | -.01897 | -.02050 | -.01713 | -.01623 | -.01890 |
| LOAD | 26.03 | 16.49 | 13.11 | 23.71 | 20.84 | 18.98 | 24.05 | 15.74 | 11.47 | 18.94 |

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* HOUSTON PILE GROUP STUDY *

* FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *

* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 5
CYCLE NO. 2020
LOAD ON GROUP = -134.34 FROM BIG LOAD CELL, KIPS
= -138.88 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -1.78791 INCHES
WEST CAP DEFL = -1.44619 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -266. | -506. | -616. | -295. | -345. | -336. | -283. | -374. | -518. | -393. |
| 24. | -397. | -800. | -934. | -460. | -486. | -503. | -391. | -550. | -770. | -588. |
| 36. | -501. | -962. | -1220. | -558. | -611. | -630. | -518. | -725. | -1033. | -751. |
| 48. | -596. | -1127. | -1451. | -661. | -791. | -764. | -563. | -653. | -1118. | -880. |
| 60. | -709. | -1167. | -1466. | -754. | -876. | -864. | -708. | -953. | -1121. | -957. |
| 72. | -769. | -1112. | -1369. | -821. | -912. | -912. | -790. | -1019. | -1086. | -977. |
| 84. | -847. | -945. | -1203. | -822. | -915. | -937. | -847. | -1013. | -912. | -938. |
| 96. | -824. | -801. | -1030. | -862. | -985. | -891. | -866. | -990. | -754. | -885. |
| 114. | -788. | -620. | -919. | -805. | -852. | -753. | -820. | -670. | -549. | -775. |
| 132. | -711. | -430. | -554. | -666. | -700. | -606. | -739. | -698. | -411. | -613. |
| 156. | -443. | -169. | -221. | -356. | -432. | -285. | -447. | -362. | -219. | -326. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -1.85 | -1.53 | -1.81 | -1.56 | -1.71 | -1.55 | -1.72 | -1.83 | -1.63 | -1.69 |
| SLOPE | .01601 | .01670 | .01921 | .01618 | .01508 | .01477 | .01452 | .01821 | .01894 | .01662 |
| LOAD | -11.73 | -19.57 | -22.82 | -10.89 | -13.38 | -14.59 | -9.87 | -13.99 | -22.02 | -15.43 |

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*              HOUSTON PILE GROUP STUDY             *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 5
CYCLE NO. 1050
LOAD ON GROUP = 167.56 FROM BIG LOAD CELL, KIPS
= 165.93 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = 1.10677 INCHES
WEST CAP DEFL = 1.74955 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 593. | 385. | 327. | 643. | 517. | 431. | 671. | 414. | 237. | 469. |
| 24. | 889. | 597. | 496. | 947. | 704. | 652. | 925. | 609. | 391. | 690. |
| 36. | 1060. | 753. | 647. | 1200. | 830. | 800. | 1149. | 804. | 566. | 868. |
| 48. | 1236. | 879. | 726. | 1342. | 1044. | 946. | 1395. | 925. | 629. | 1013. |
| 60. | 1267. | 941. | 821. | 1389. | 1082. | 1036. | 1384. | 989. | 690. | 1067. |
| 72. | 1185. | 998. | 858. | 1342. | 1112. | 1112. | 1298. | 1007. | 765. | 1075. |
| 84. | 978. | 964. | 884. | 1190. | 1025. | 1070. | 1164. | 948. | 795. | 1002. |
| 96. | 816. | 888. | 810. | 971. | 905. | 945. | 861. | 830. | 735. | 862. |
| 114. | 514. | 782. | 596. | 682. | 710. | 793. | 559. | 633. | 692. | 663. |
| 132. | 261. | 649. | 600. | 443. | 541. | 642. | 366. | 467. | 577. | 505. |
| 156. | 37. | 364. | 312. | 174. | 275. | 316. | 110. | 191. | 340. | 235. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | 1.38 | 1.75 | 1.47 | 1.73 | 1.61 | 1.76 | 1.56 | 1.45 | 1.67 | 1.60 |
| SLOPE | -.02007 | -.01877 | -.01540 | -.02461 | -.01794 | -.01890 | -.02048 | -.01702 | -.01609 | -.01881 |
| LOAD | 25.27 | 15.63 | 12.48 | 23.36 | 20.39 | 18.58 | 23.74 | 15.40 | 11.07 | 18.44 |

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*             HOUSTON PILE GROUP STUDY              *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 5
CYCLE NO. 2050
LOAD ON GROUP = -142.36 FROM BIG LOAD CELL, KIPS
= -140.27 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -1.80882 INCHES
WEST CAP DEFL = -1.46200 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -286. | -536. | -642. | -315. | -378. | -362. | -307. | -400. | -543. | -419. |
| 24. | -426. | -845. | -966. | -487. | -524. | -534. | -419. | -579. | -863. | -620. |
| 36. | -525. | -1006. | -1253. | -581. | -646. | -660. | -541. | -753. | -1071. | -782. |
| 48. | -614. | -1169. | -1483. | -680. | -826. | -790. | -584. | -876. | -1154. | -906. |
| 60. | -723. | -1202. | -1500. | -760. | -902. | -883. | -721. | -969. | -1151. | -979. |
| 72. | -777. | -1138. | -1397. | -825. | -932. | -924. | -792. | -1031. | -1109. | -992. |
| 84. | -851. | -963. | -1224. | -817. | -922. | -944. | -845. | -1022. | -941. | -948. |
| 96. | -822. | -812. | -1043. | -859. | -994. | -896. | -860. | -992. | -764. | -894. |
| 114. | -788. | -626. | -922. | -808. | -852. | -753. | -817. | -874. | -548. | -777. |
| 132. | -714. | -431. | -558. | -672. | -701. | -606. | -740. | -702. | -407. | -614. |
| 156. | -450. | -167. | -216. | -361. | -431. | -283. | -452. | -365. | -212. | -326. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -1.86 | -1.53 | -1.82 | -1.56 | -1.70 | -1.56 | -1.73 | -1.86 | -1.67 | -1.70 |
| SLOPE | .01602 | .01668 | .01924 | .01620 | .01548 | .01513 | .01509 | .01832 | .01967 | .01667 |
| LOAD | -12.29 | -20.09 | -22.85 | -10.94 | -13.59 | -14.65 | -9.94 | -13.93 | -21.99 | -15.59 |

HOUSTON PILE GROUP STUDY

FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 5
CYCLE NO. 1100
LOAD ON GROUP = 179.25 FROM BIG LOAD CELL, KIPS
= 173.69 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = 1.09007 INCHES
WEST CAP DEFL = 1.72079 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 632. | 409. | 347. | 690. | 547. | 461. | 711. | 435. | 245. | 497. |
| 24. | 920. | 605. | 507. | 989. | 736. | 681. | 976. | 637. | 404. | 717. |
| 36. | 1101. | 770. | 664. | 1249. | 863. | 831. | 1203. | 839. | 575. | 899. |
| 48. | 1288. | 891. | 737. | 1386. | 1074. | 967. | 1440. | 941. | 627. | 1039. |
| 60. | 1300. | 940. | 822. | 1423. | 1109. | 1061. | 1431. | 1016. | 698. | 1089. |
| 72. | 1213. | 1006. | 868. | 1371. | 1136. | 1140. | 1332. | 1035. | 775. | 1097. |
| 84. | 992. | 968. | 890. | 1204. | 1039. | 1077. | 1174. | 958. | 783. | 1009. |
| 96. | 820. | 885. | 812. | 967. | 909. | 945. | 856. | 834. | 741. | 863. |
| 114. | 502. | 775. | 595. | 661. | 700. | 780. | 542. | 622. | 683. | 651. |
| 132. | 243. | 638. | 587. | 416. | 520. | 618. | 341. | 446. | 566. | 486. |
| 156. | 17. | 349. | 297. | 153. | 255. | 298. | 88. | 173. | 330. | 218. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | 1.36 | 1.73 | 1.46 | 1.71 | 1.59 | 1.73 | 1.54 | 1.43 | 1.66 | 1.58 |
| SLOPE | -.02019 | -.01861 | -.01525 | -.02470 | -.01794 | -.01894 | -.02075 | -.01716 | -.01616 | -.01886 |
| LOAD | 26.79 | 16.37 | 13.18 | 24.62 | 21.31 | 19.31 | 24.80 | 16.00 | 11.30 | 19.30 |

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*                 HOUSTON PILE GROUP STUDY                   *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984         *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 5
CYCLE NO. 2100
LOAD ON GROUP = -130.17 FROM BIG LOAD CELL, KIPS
= -134.94 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -1.84647 INCHES
WEST CAP DEFL = -1.46594 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -250. | -495. | -593. | -277. | -334. | -326. | -269. | -359. | -507. | -379. |
| 24. | -376. | -784. | -902. | -440. | -476. | -492. | -374. | -530. | -751. | -564. |
| 36. | -478. | -950. | -1196. | -531. | -602. | -620. | -499. | -706. | -1031. | -735. |
| 48. | -567. | -1136. | -1451. | -637. | -795. | -757. | -540. | -841. | -1136. | -873. |
| 60. | -688. | -1190. | -1493. | -721. | -883. | -861. | -691. | -949. | -1152. | -959. |
| 72. | -752. | -1137. | -1399. | -799. | -934. | -913. | -769. | -1022. | -1119. | -983. |
| 84. | -837. | -968. | -1230. | -797. | -918. | -940. | -830. | -1019. | -952. | -94[illegible]. |
| 96. | -809. | -815. | -1045. | -848. | -1009. | -895. | -852. | -989. | -768. | -892. |
| 114. | -783. | -621. | -914. | -805. | -848. | -748. | -811. | -871. | -551. | -772. |
| 132. | -708. | -425. | -549. | -669. | -697. | -600. | -735. | -697. | -400. | -605. |
| 156. | -453. | -165. | -211. | -363. | -428. | -279. | -455. | -363. | -206. | -325. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -1.86 | -1.52 | -1.82 | -1.56 | -1.70 | -1.54 | -1.72 | -1.84 | -1.64 | -1.69 |
| SLOPE | .01578 | .01663 | .01920 | .01588 | .01506 | .01465 | .01431 | .01814 | .01894 | .01651 |
| LOAD | -11.16 | -19.06 | -21.93 | -10.36 | -13.89 | -14.15 | -9.43 | -13.46 | -21.48 | -14.99 |

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*                  HOUSTON PILE GROUP STUDY                     *
*  FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984            *
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NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

LOAD NO. 5
CYCLE NO. 1200
LOAD ON GROUP = 180.55 FROM BIG LOAD CELL, KIPS
= 178.33 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = 1.49079 INCHES
WEST CAP DEFL = 2.03099 INCHES

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | 644. | 415. | 355. | 703. | 566. | 485. | 732. | 461. | 261. | 514. |
| 24. | 964. | 637. | 544. | 1034. | 780. | 725. | 1016. | 676. | 426. | 756. |
| 36. | 1163. | 810. | 703. | 1309. | 913. | 882. | 1286. | 885. | 603. | 950. |
| 48. | 1406. | 946. | 799. | 1501. | 1172. | 1069. | 1571. | 1036. | 695. | 1133. |
| 60. | 1433. | 1025. | 910. | 1561. | 1222. | 1197. | 1582. | 1135. | 759. | 1203. |
| 72. | 1338. | 1097. | 958. | 1516. | 1277. | 1268. | 1486. | 1160. | 857. | 1217. |
| 84. | 1097. | 1072. | 1003. | 1342. | 1175. | 1212. | 1314. | 1087. | 884. | 1132. |
| 96. | 933. | 1002. | 939. | 1100. | 1050. | 1071. | 975. | 963. | 857. | 988. |
| 114. | 614. | 896. | 760. | 791. | 830. | 908. | 659. | 755. | 800. | 779. |
| 132. | 356. | 769. | 743. | 553. | 647. | 747. | 465. | 581. | 682. | 616. |
| 156. | 109. | 457. | 414. | 245. | 361. | 400. | 179. | 272. | 429. | 318. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | 1.69 | 2.07 | 1.79 | 2.04 | 1.92 | 2.07 | 1.86 | 2.02 | 1.97 | 1.94 |
| SLOPE | -.02313 | -.02108 | -.01804 | -.02819 | -.02067 | -.02176 | -.02367 | .00315 | -.01875 | -.01913 |
| LOAD | 27.02 | 16.66 | 13.51 | 25.08 | 21.17 | 20.32 | 25.57 | 16.98 | 12.01 | 19.81 |

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* HOUSTON PILE GROUP STUDY *

* FIELD DATA FROM LATERAL LOAD TEST OF DEC 13, 1984 *

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LOAD NO. 5
CYCLE NO. 2200
LOAD ON GROUP = -140.41 FROM BIG LOAD CELL, KIPS
= -138.06 FROM SUM OF PILE LOAD CELLS
EAST CAP DEFL = -1.47187 INCHES
WEST CAP DEFL = -1.13414 INCHES

NORTH

| | | |
|---|---|---|
| D | G | A |
| F | E | H |
| B | I | C |

PILE LEGEND

BENDING MOMENTS, INCH-KIPS

| DEPTH, INCHES | PILE A | PILE B | PILE C | PILE D | PILE E | PILE F | PILE G | PILE H | PILE I | AVG |
|---|---|---|---|---|---|---|---|---|---|---|
| 12. | -240. | -504. | -608. | -263. | -330. | -322. | -259. | -359. | -515. | -378. |
| 24. | -361. | -804. | -925. | -420. | -470. | -485. | -354. | -527. | -760. | -567. |
| 36. | -444. | -955. | -1216. | -495. | -586. | -604. | -451. | -695. | -1038. | -721. |
| 48. | -494. | -1132. | -1455. | -577. | -762. | -711. | -481. | -809. | -1131. | -839. |
| 60. | -612. | -1162. | -1474. | -642. | -828. | -780. | -613. | -880. | -1132. | -503. |
| 72. | -669. | -1077. | -1340. | -698. | -809. | -824. | -667. | -932. | -1063. | -898. |
| 84. | -750. | -878. | -1132. | -690. | -811. | -831. | -724. | -917. | -870. | -845. |
| 96. | -697. | -698. | -916. | -735. | -854. | -772. | -733. | -858. | -654. | -769. |
| 114. | -650. | -474. | -763. | -652. | -695. | -599. | -672. | -713. | -420. | -626. |
| 132. | -560. | -266. | -361. | -492. | -537. | -428. | -574. | -522. | -252. | -444. |
| 156. | -331. | -40. | -67. | -237. | -290. | -158. | -325. | -234. | -77. | -196. |
| AT LOAD POINT: | | | | | | | | | | |
| DEFL | -1.51 | -1.17 | -1.47 | -1.22 | -1.36 | -1.20 | -1.38 | -2.14 | -1.29 | -1.41 |
| SLOPE | .01298 | .01428 | .01692 | .01263 | .01251 | .01194 | .01149 | -.04252 | .01653 | .00741 |
| LOAD | -11.62 | -20.37 | -23.29 | -10.38 | -13.47 | -14.34 | -9.27 | -13.50 | -21.83 | -15.34 |

END
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